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Wave Propagation   Submillimeter Applications

Pattern Handbook
Volume IV: Far-Field Patterns of a Linear
Antenna Radiating in the Presence
of Rectangular Cylinders

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Prepared for:
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Code 3300b
San Diego, California

Department of ELECTRICAL ENGINEERING

THE OHIO STATE UNIVERSITY
RESEARCH FOUNDATION
Columbus, Ohio

REPORT
by
THE OHIO STATE UNIVERSITY RESEARCH FOUNDATION
COLUMBUS, OHIO 43212

Sponsor	U.S. Navy Electronics Laboratory Code 3300b San Diego, California
Contract No.	N123(953)-31663A
Investigation of	Study Program Related to Shipboard Antenna System Environment
Subject of Report	Pattern Handbook Volume IV: Far-Field Patterns of a Linear Antenna Radiating in the Presence of Rectangular Cylinders
Submitted by	C.H. Brenner Antenna Laboratory Department of Electrical Engineering
Date	1 August 1965

PREFACE

The prediction of fields radiated by shipboard antennas is complicated by the presence of parasitically excited superstructure which warps and deteriorates the far-field patterns. If antennas are to be located in some logical manner on the ship, or if the ship design itself is to take account of the primary radiating elements, then some guides must be found to account for the influence of superstructure on antenna patterns. To this end, a handbook has been compiled, giving patterns of a thin, linear, vertical antenna radiating in the presence of cylindrical conducting structures of various cross-sectional shape. The model used to approximate this configuration is that of an infinite line source, representing the dipole, radiating in the presence of an array of thin, infinite wires parallel to each other and outlining the surface of the offending cylindrical structure. It has been shown [1] that such a wire approximation is electrically similar to the solid metallic surface if at least 5 wires per wavelength of perimeter are used. It has also been shown[2] that the patterns obtained from the infinitely tall model in the plane normal to the cylinder axis are good approximations to those obtained from the actual finite height configuration so long as the offending structure is taller than the source antenna, preferably twice as tall[3] .

Because long distance communication systems aboard ship usually operate at wavelenghts between 10 and 100 meters, structures which have rather sizeabl physical dimensions are not very large in terms of wavelength. For this reason, only offending structures up to 2 wavelengths on a side are considered. It has been found from sample calculations that patterns for objects larger than 2 wavelengths on a side do not differ radically from those for the largest objects presented in this handbook.

The computer program used to calculate the patterns in this handbook is an automated version of the SCATRAN program described in Reference 2. Certain innovations were incorporated to improve efficiency of operation.

ACKNOWLEDGEMENT

The author wishes to acknowledge the assistance of Mr. G. A. Thiele in modifying the computer program and in preparing this handbook.

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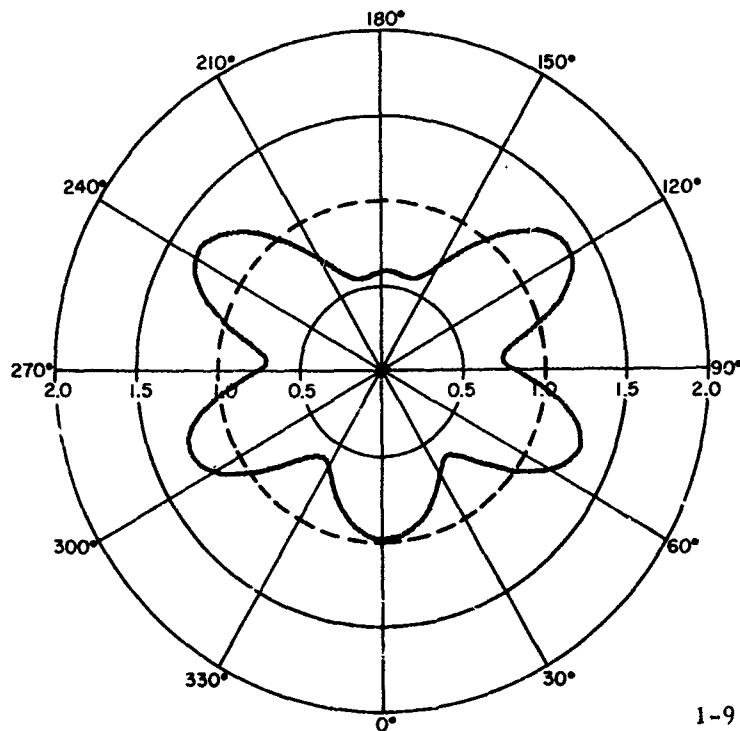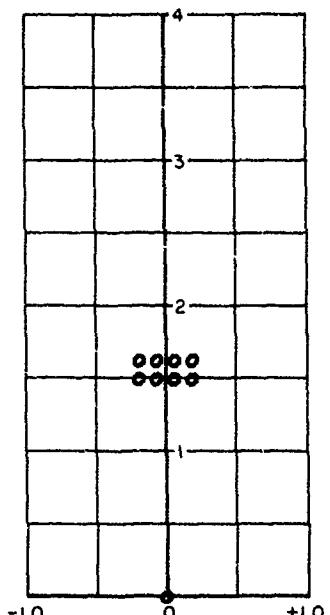
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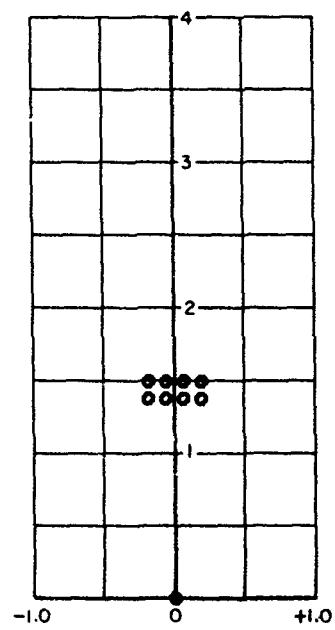
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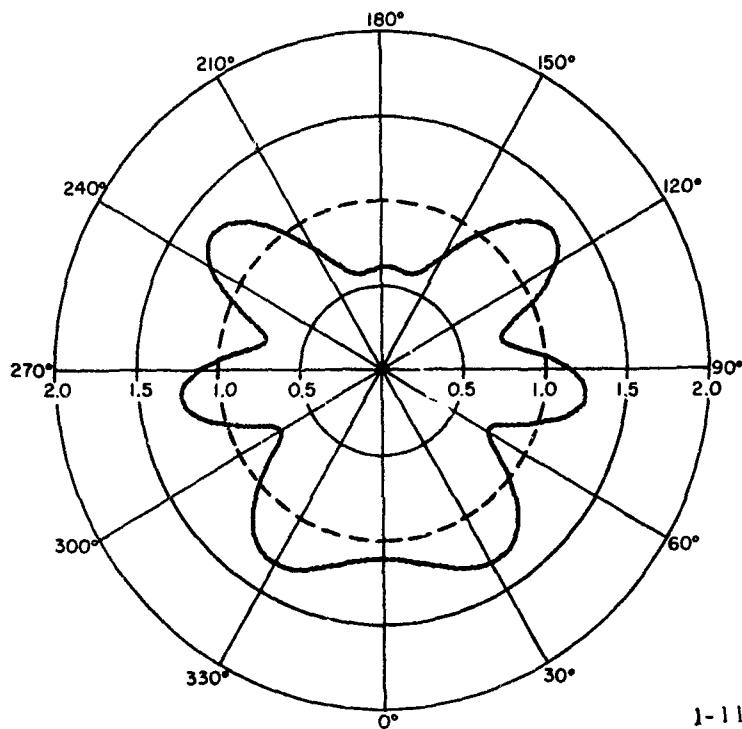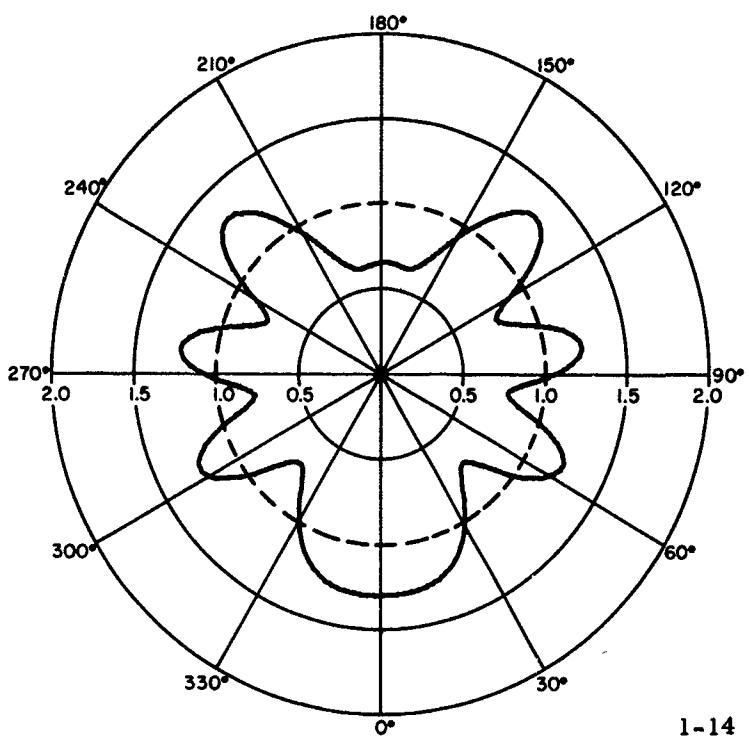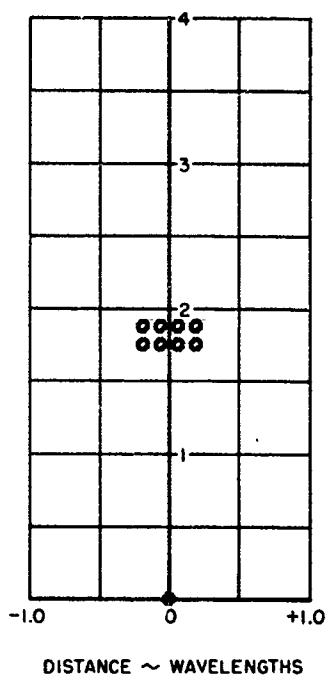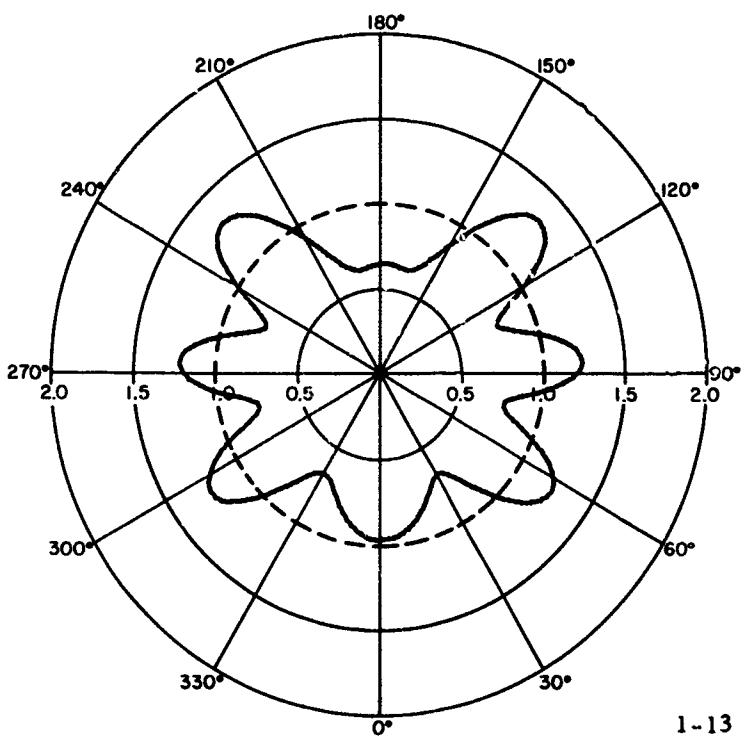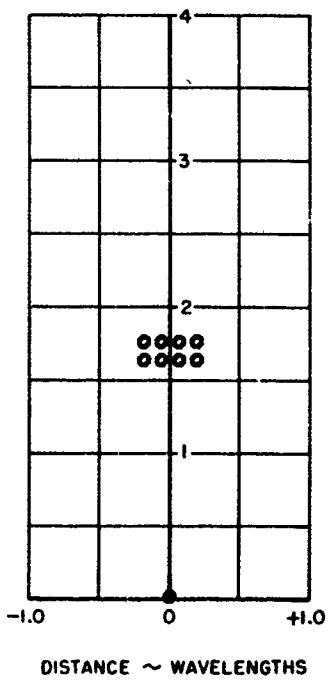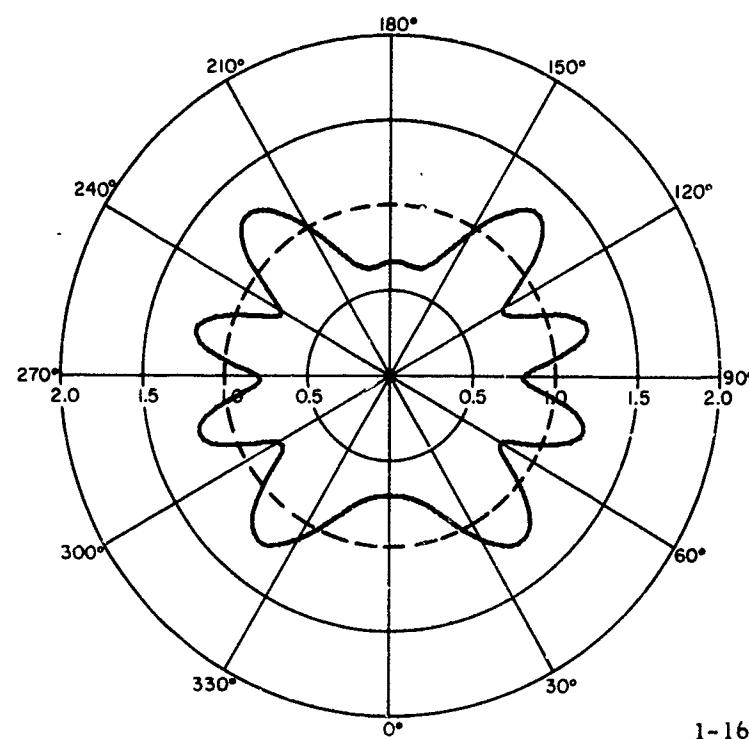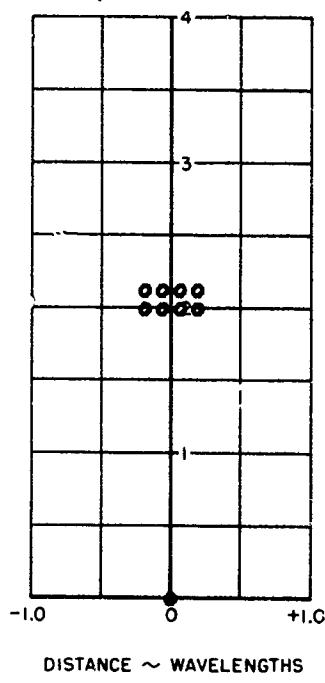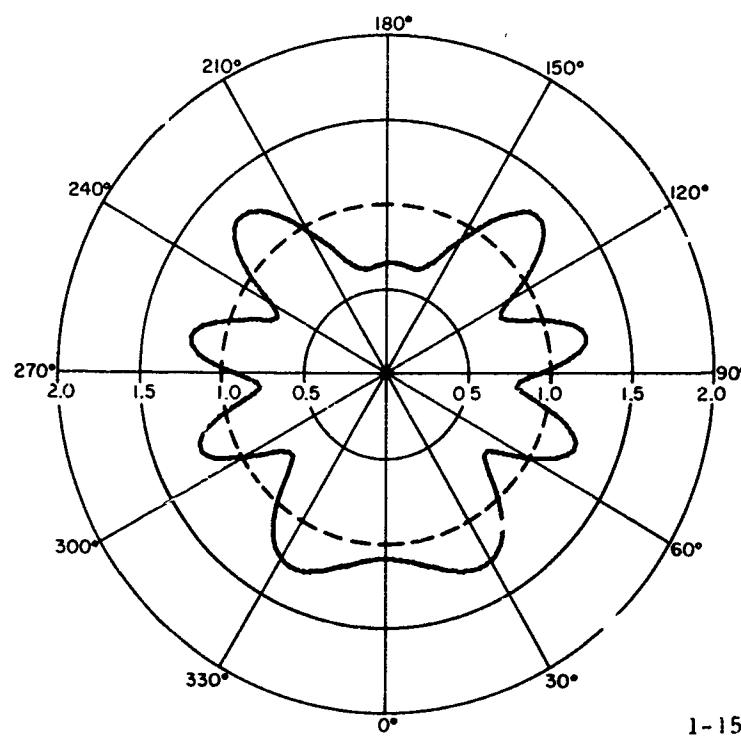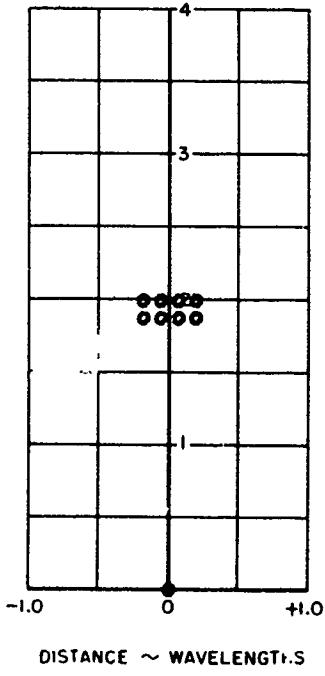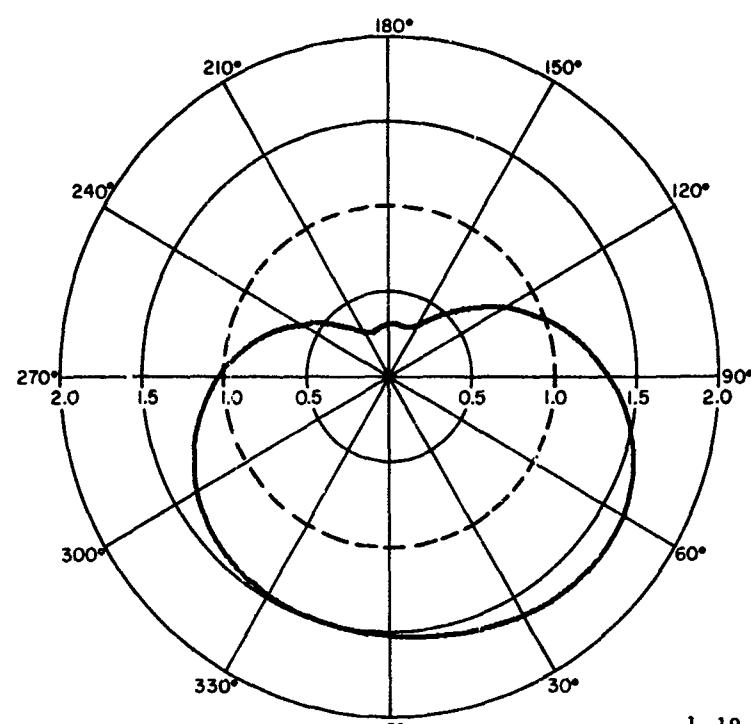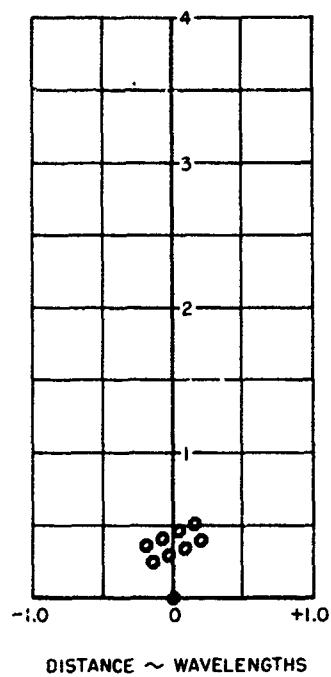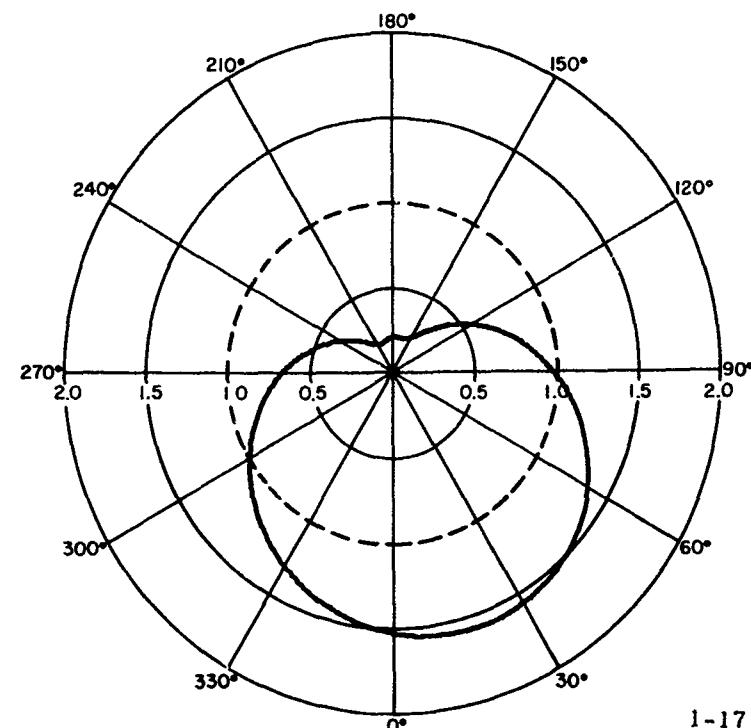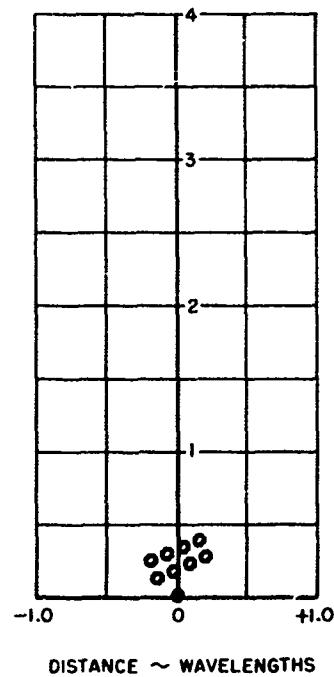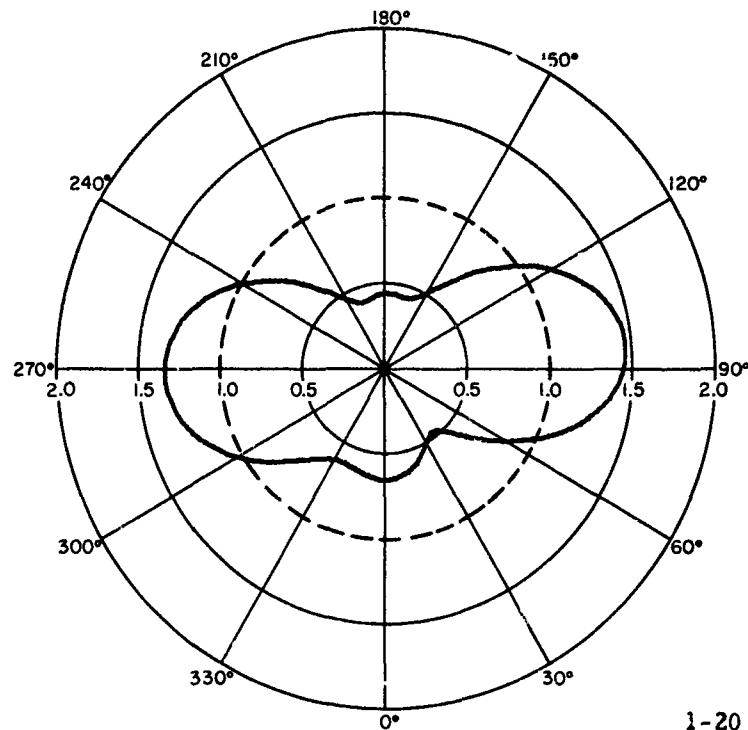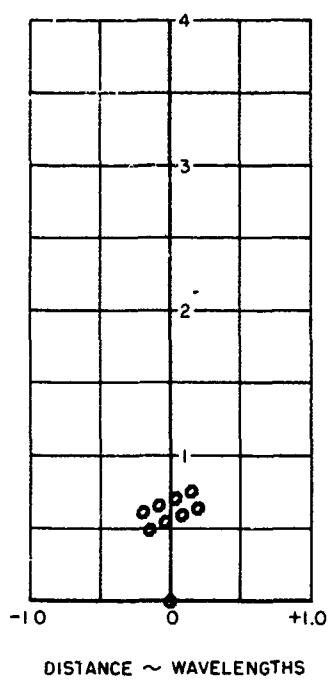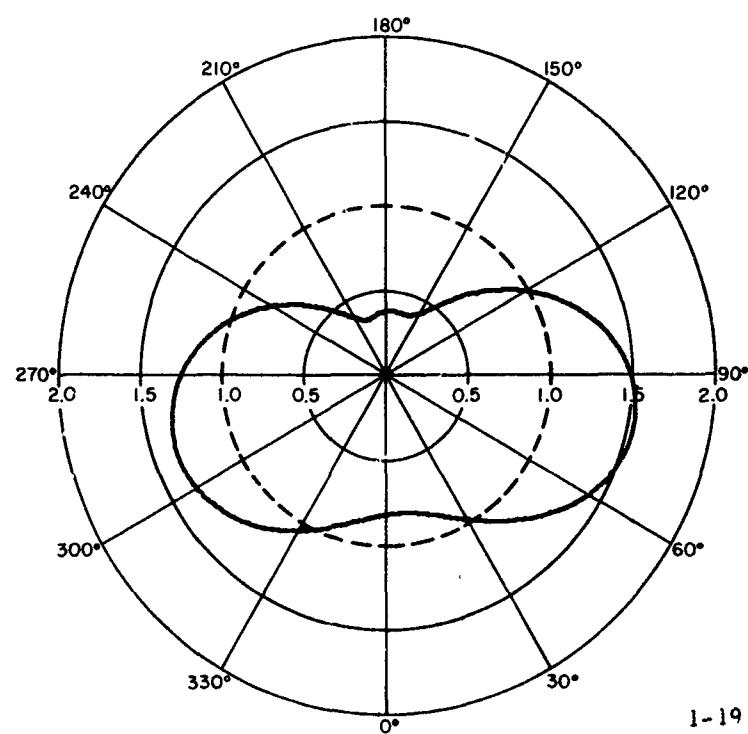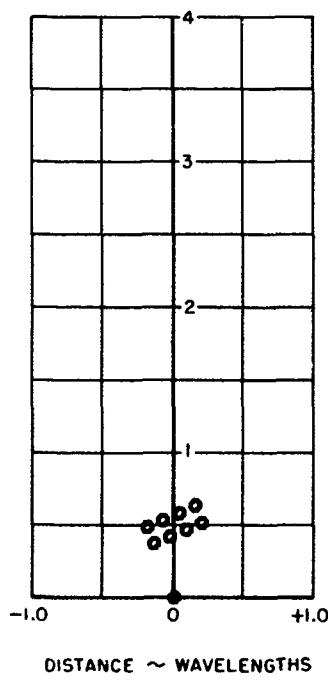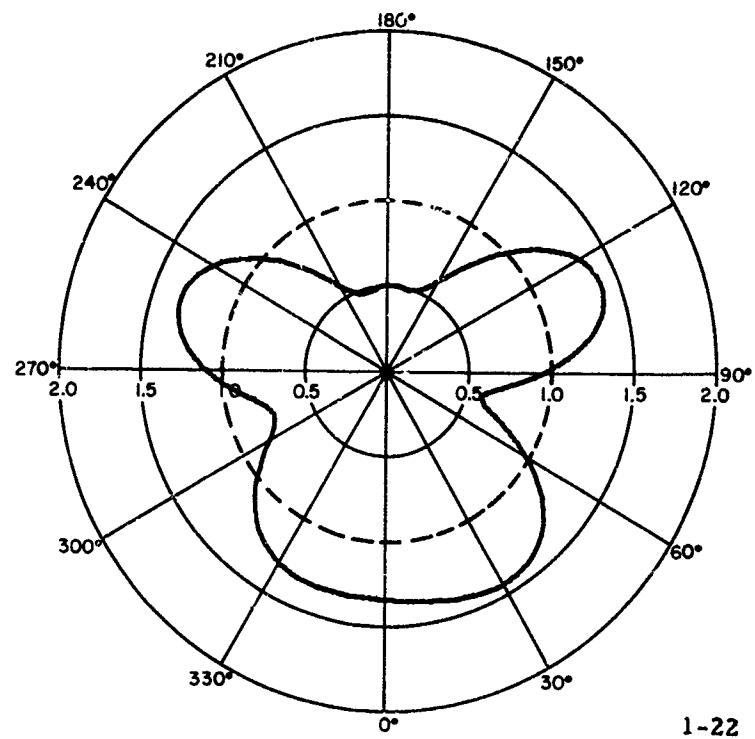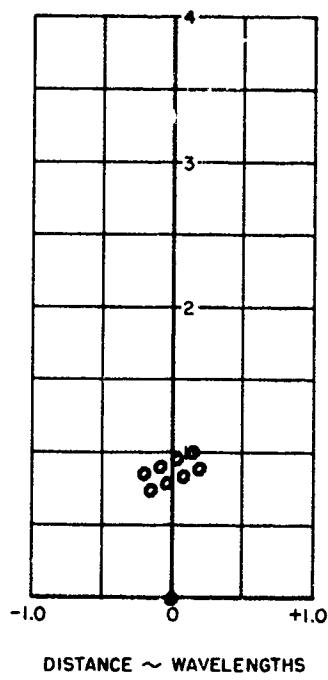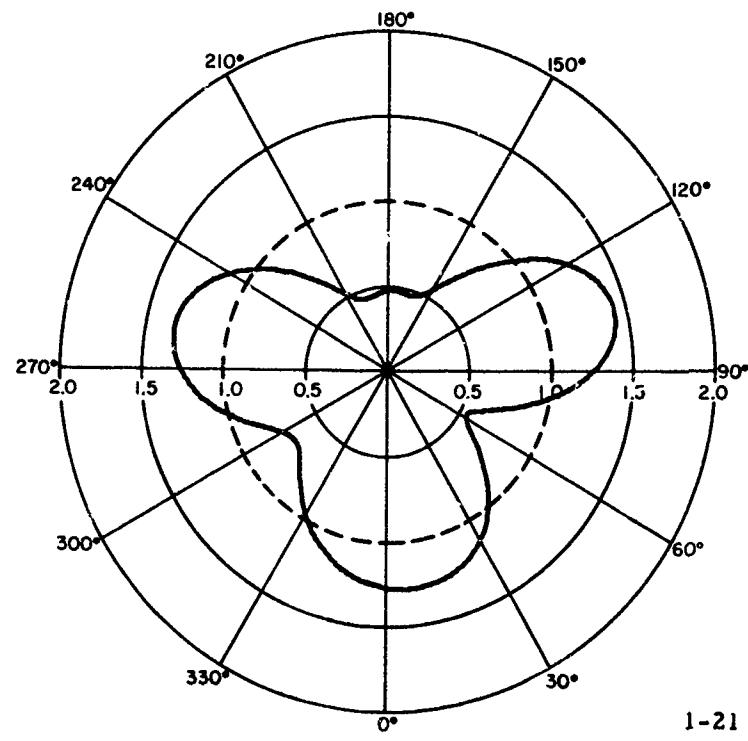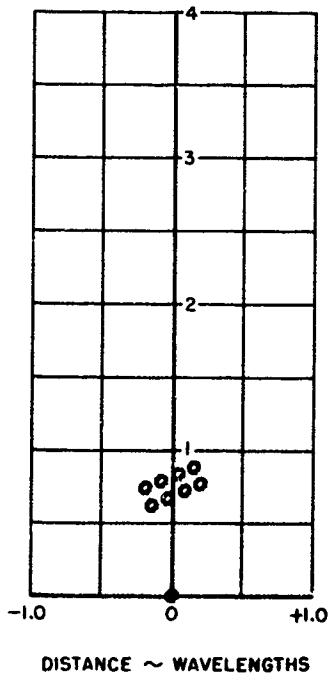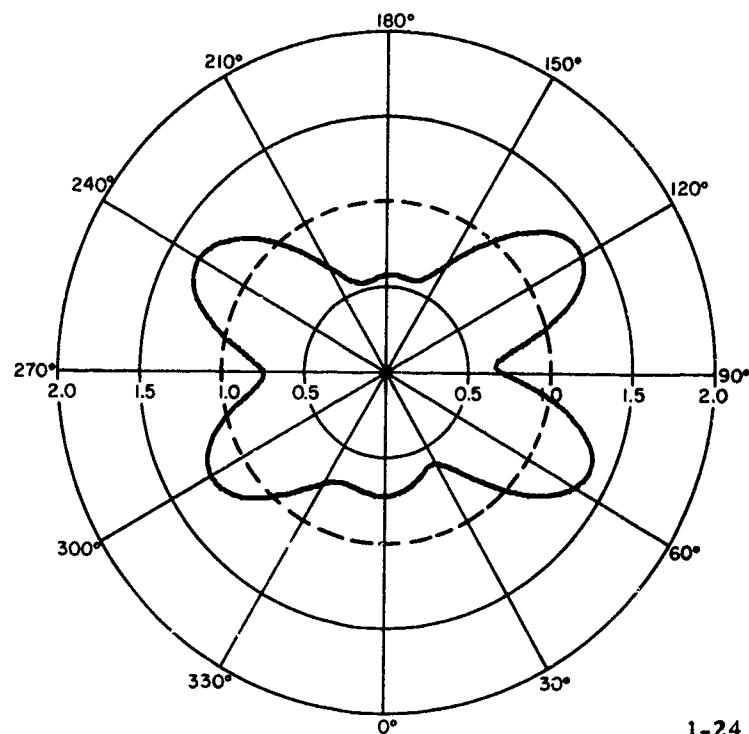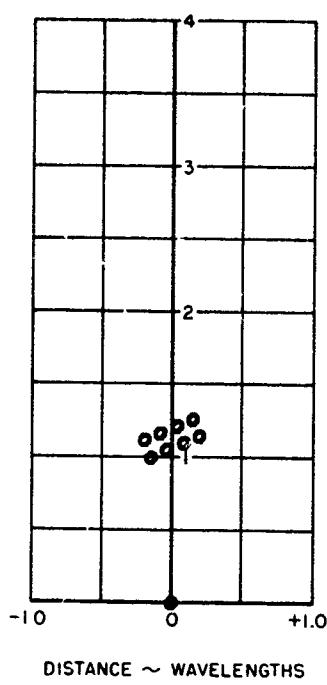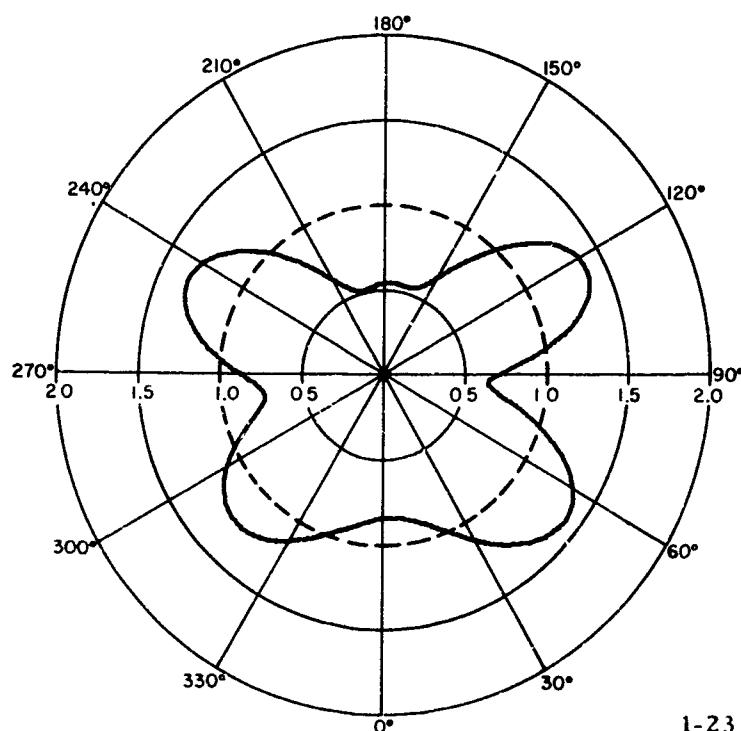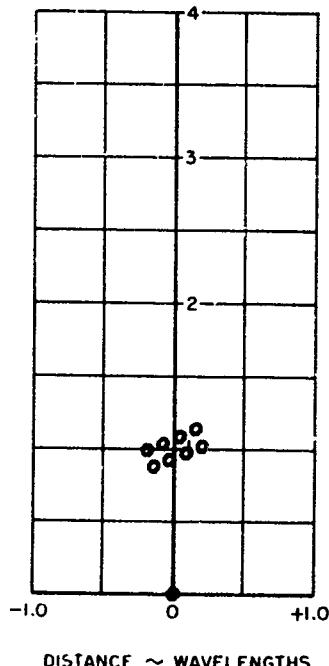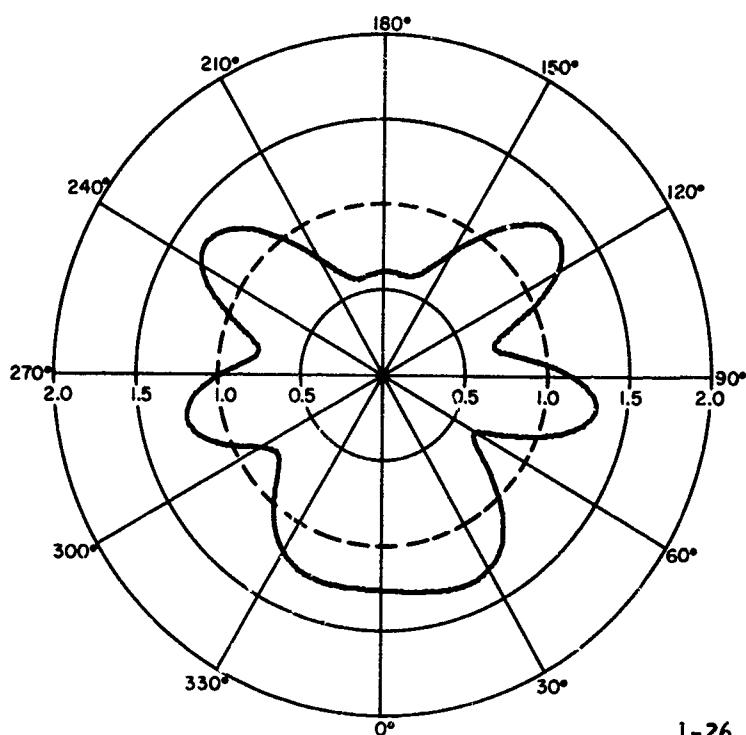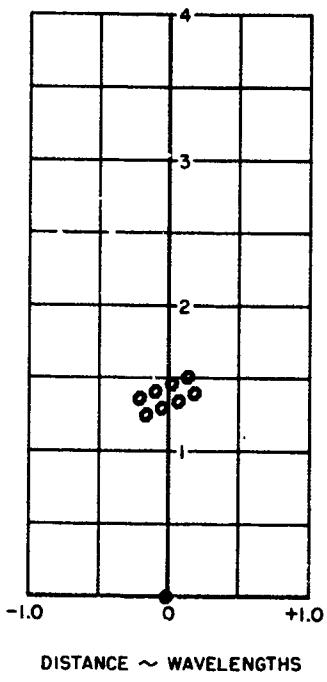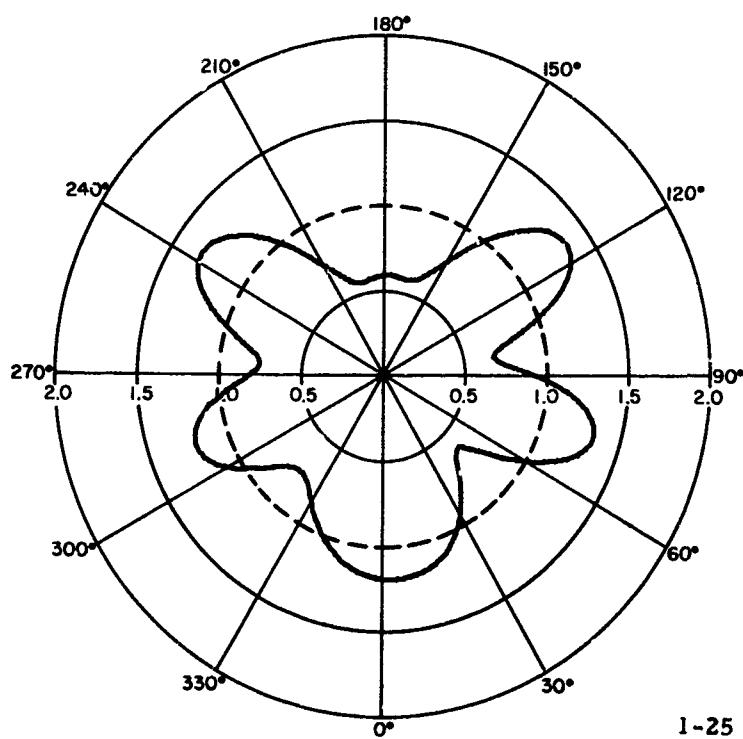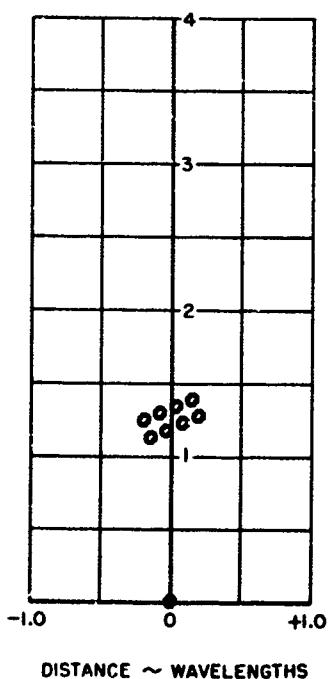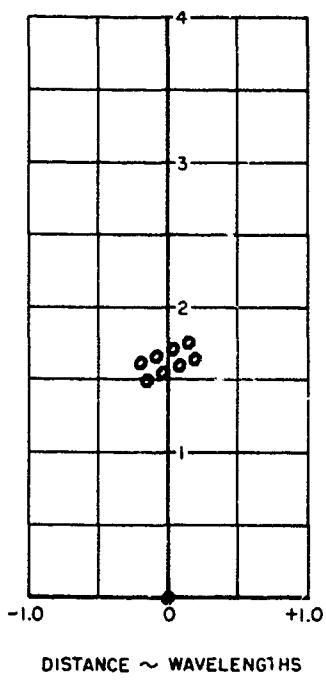
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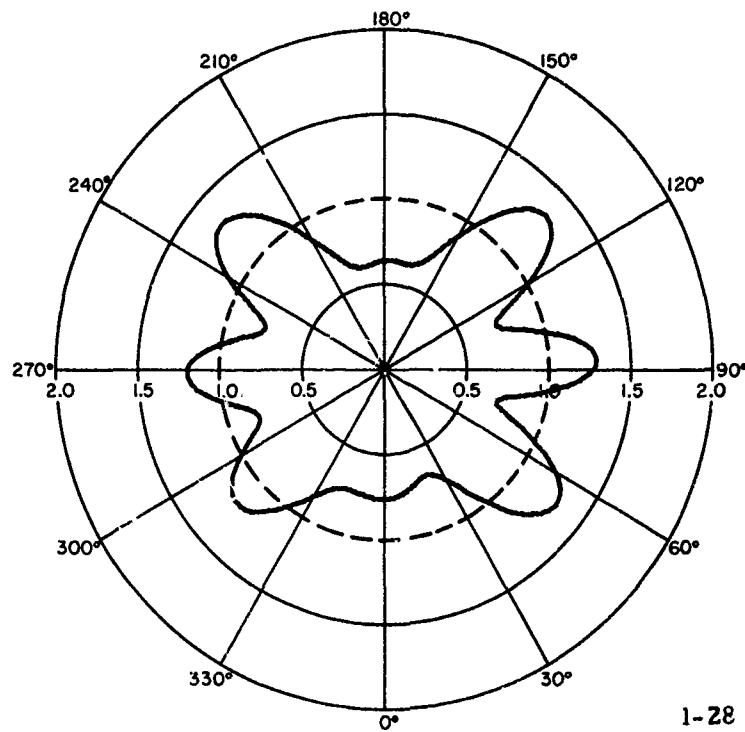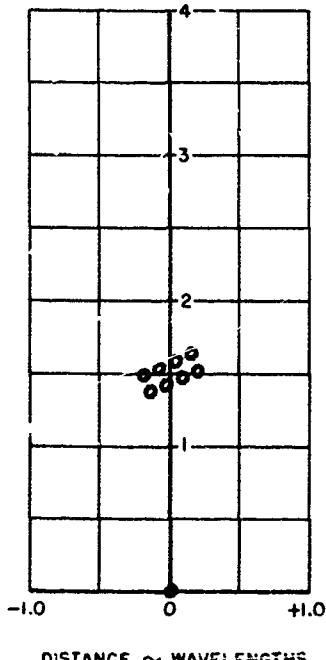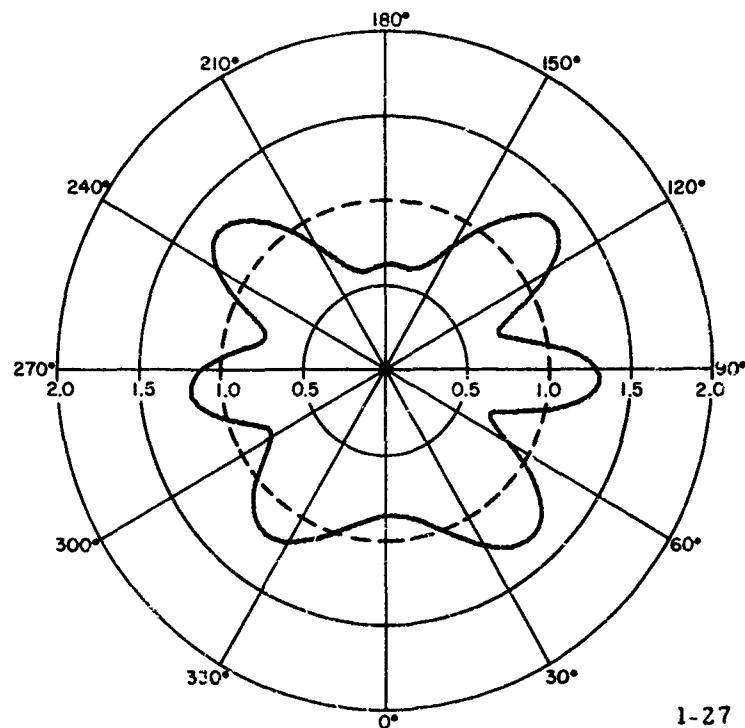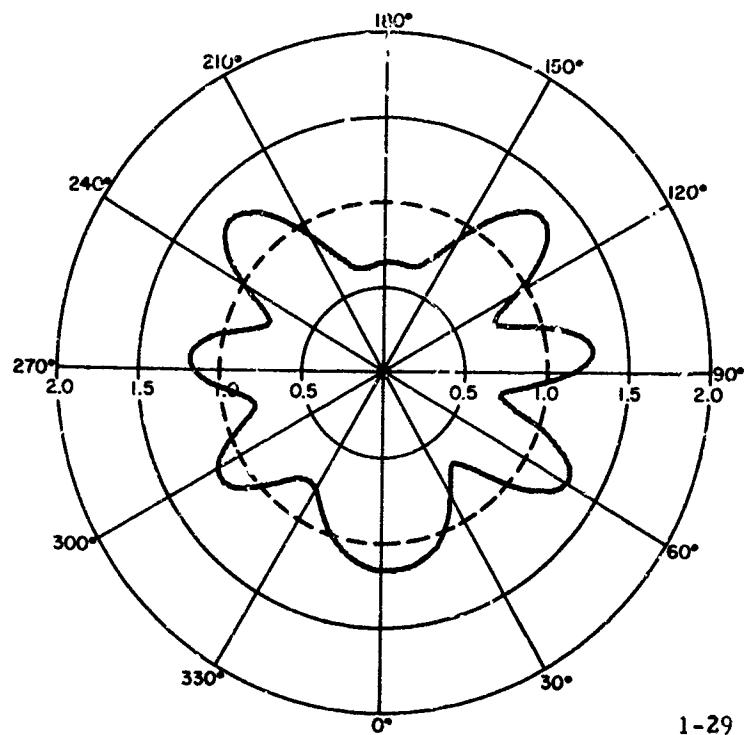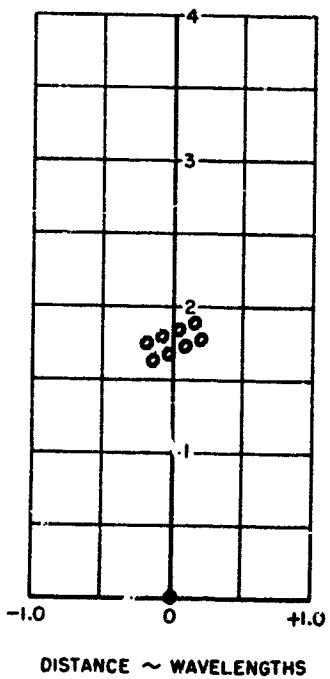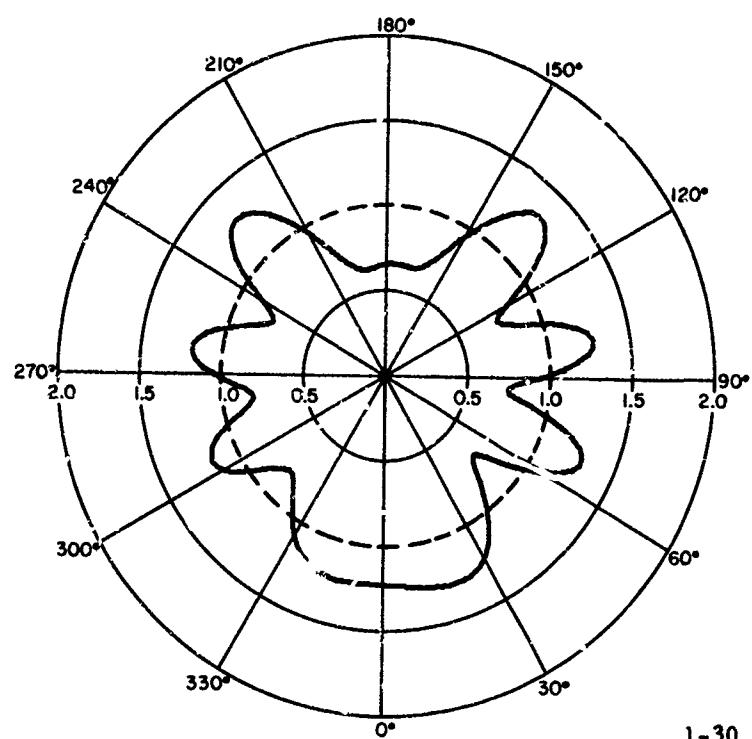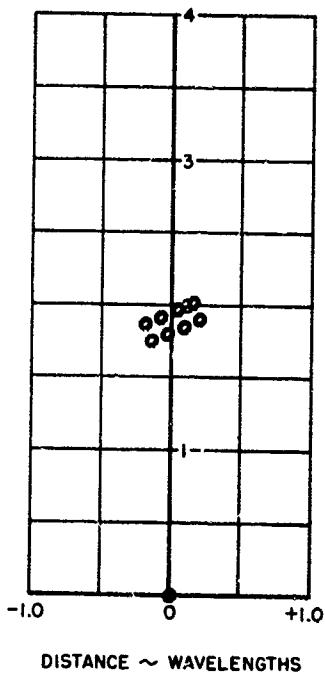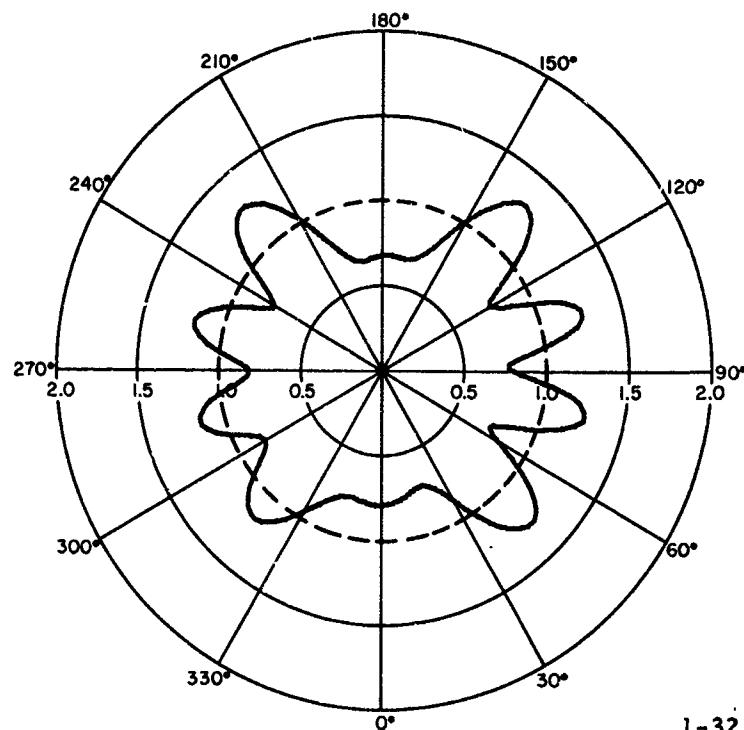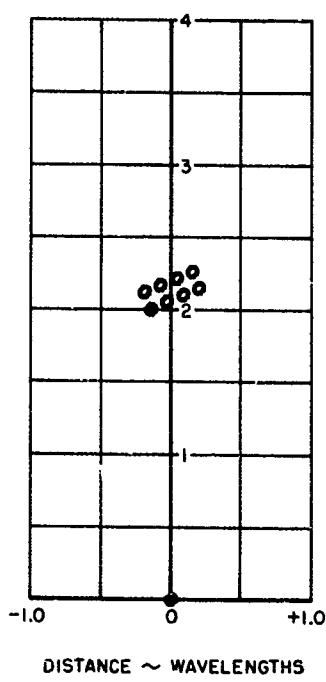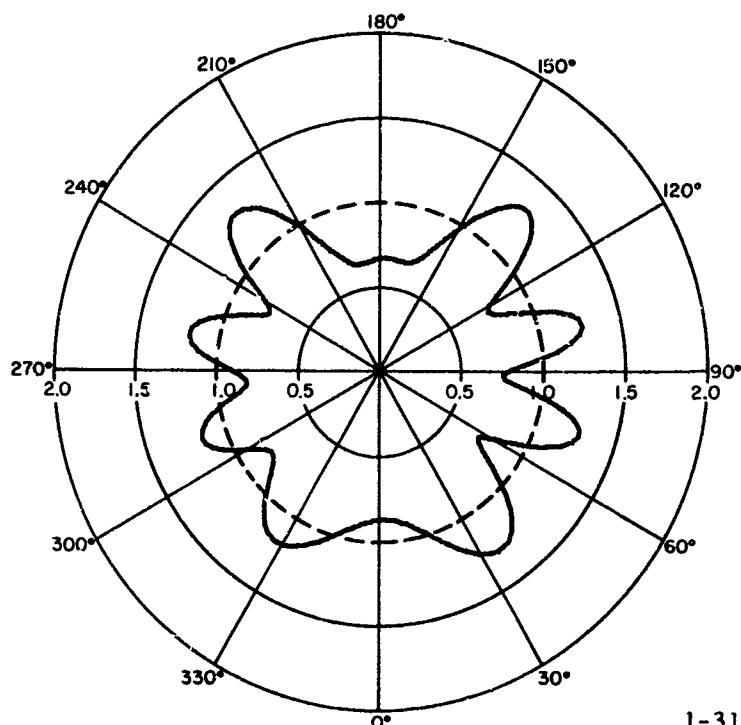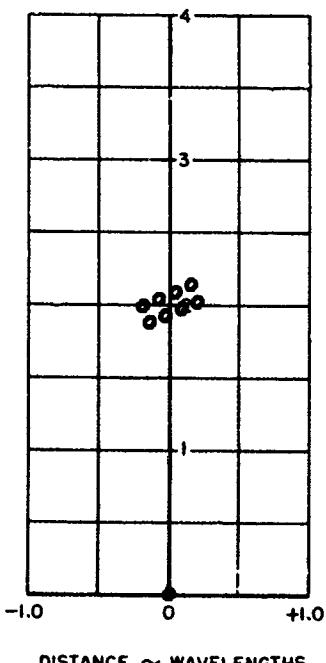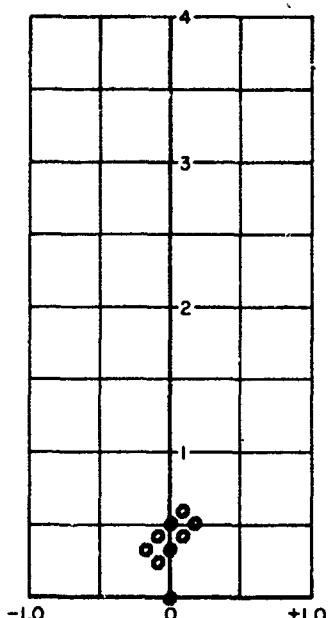
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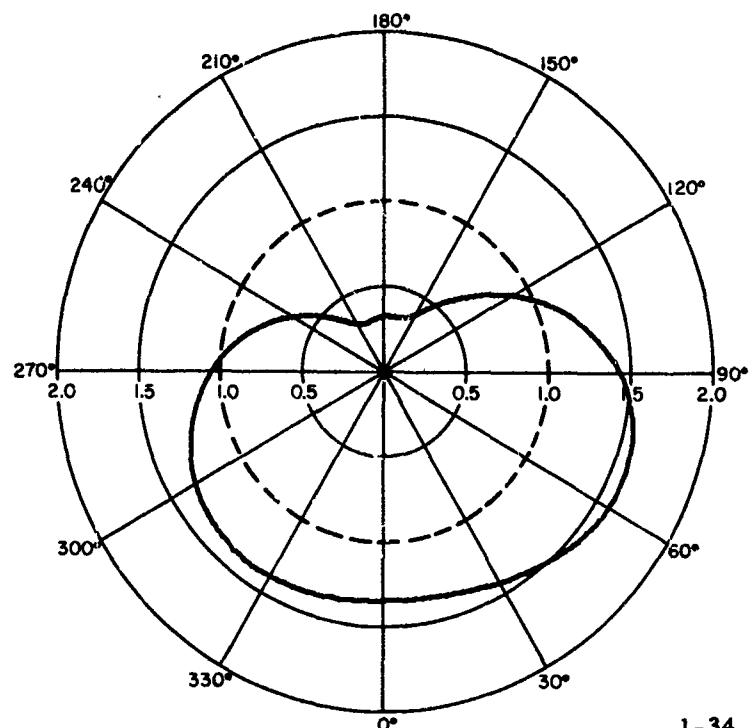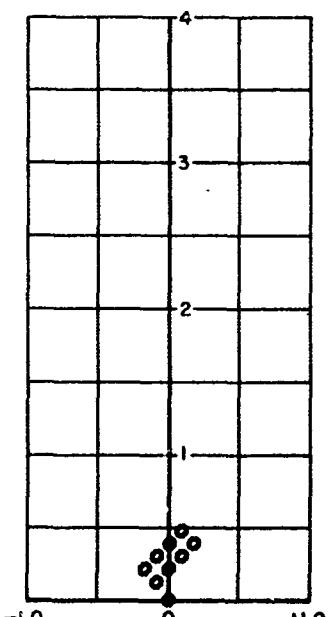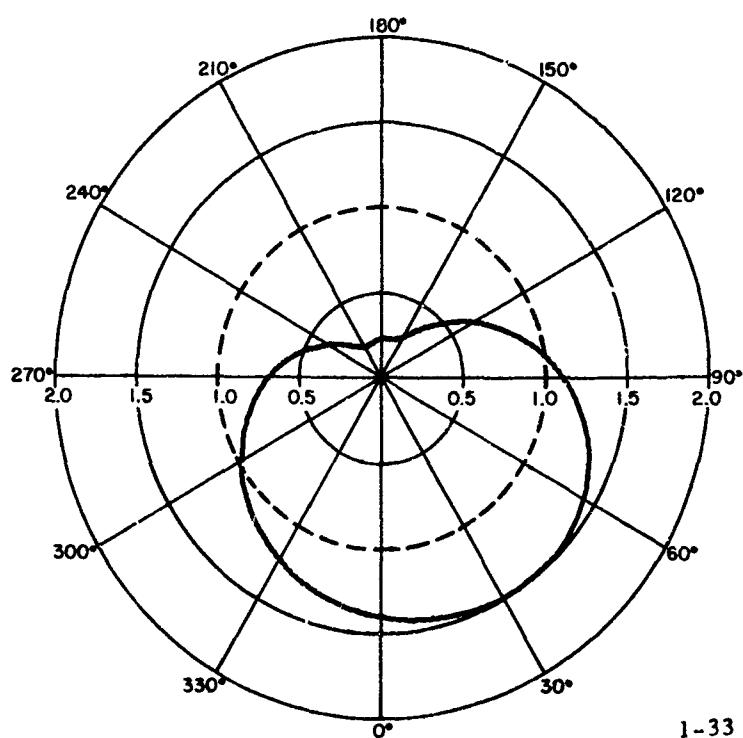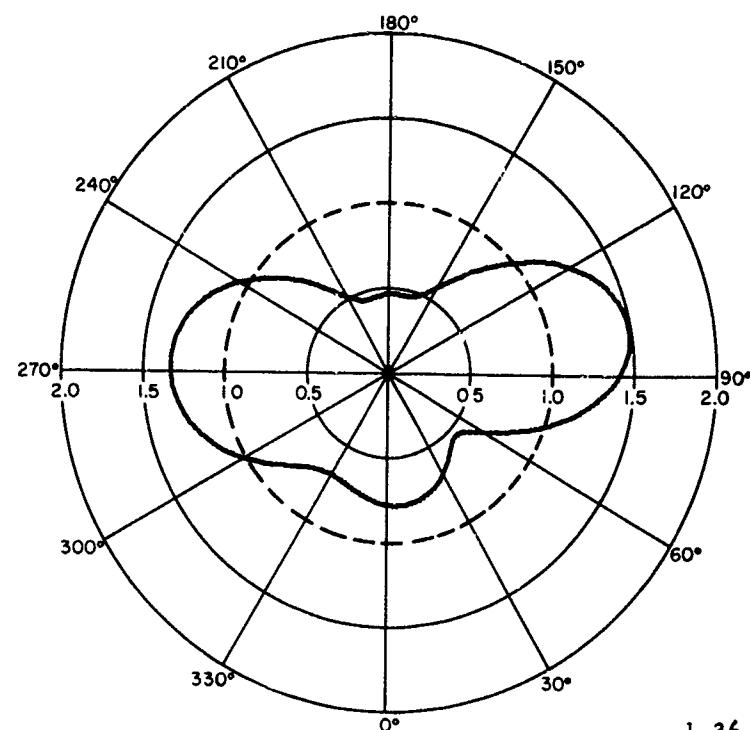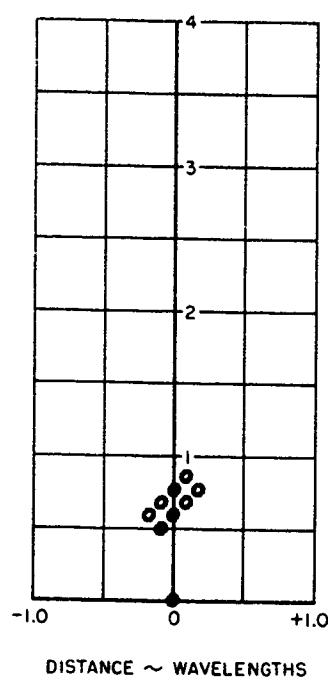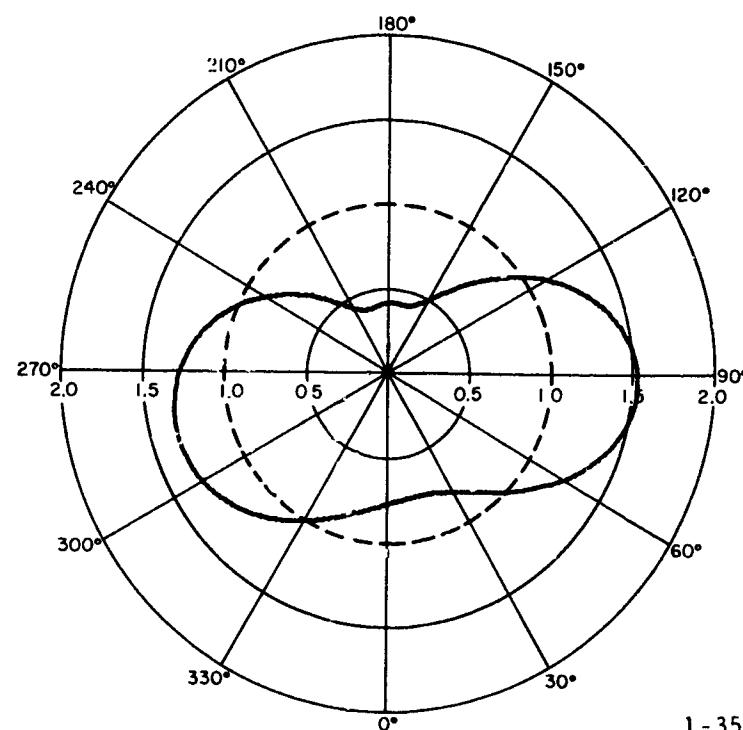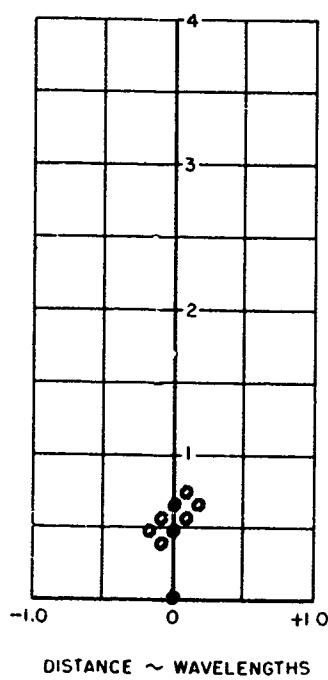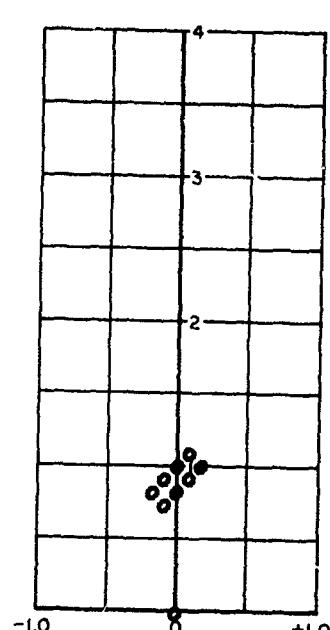
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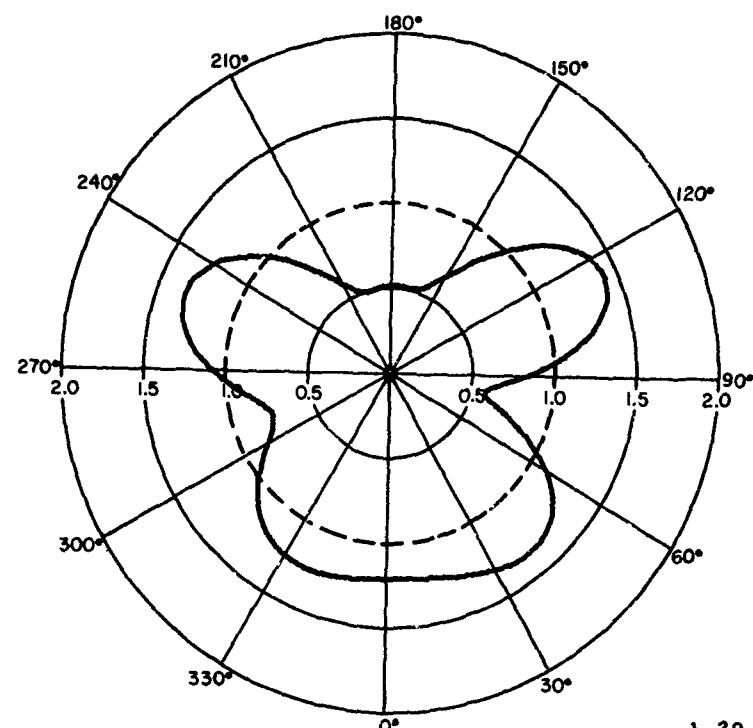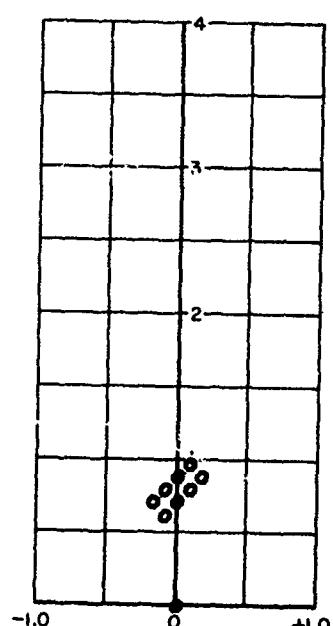
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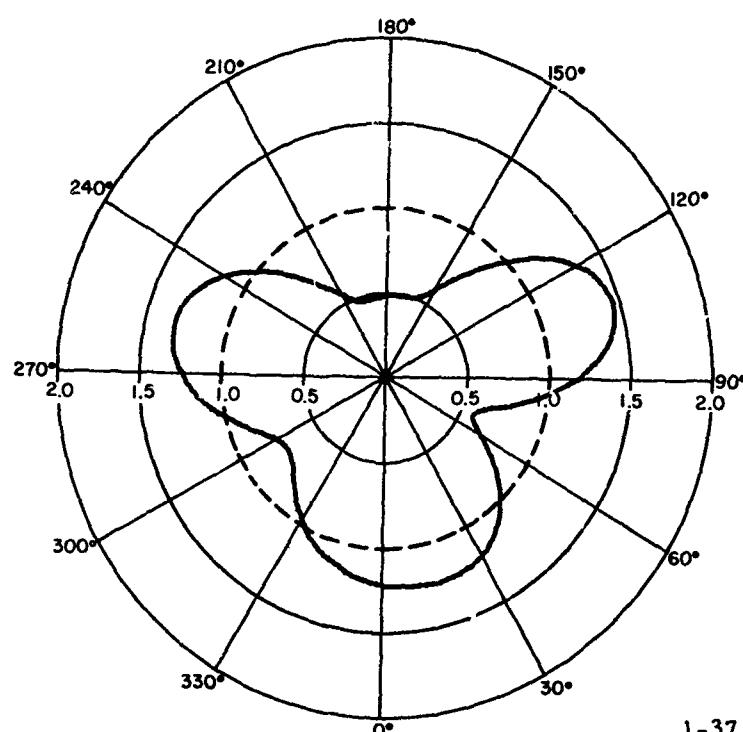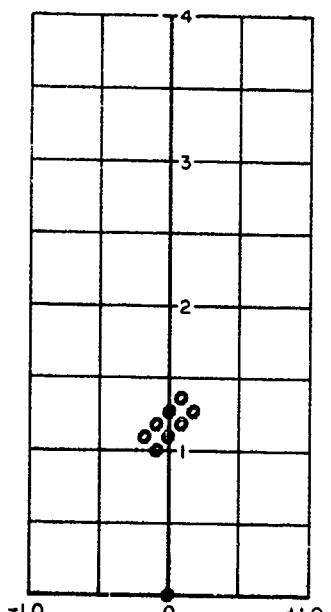
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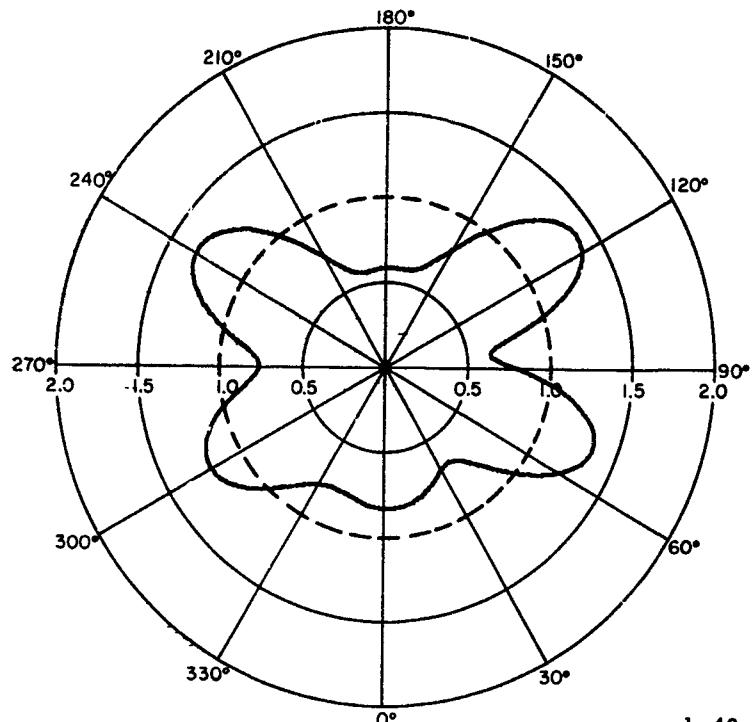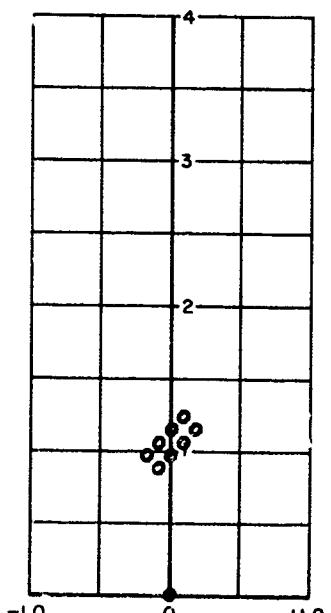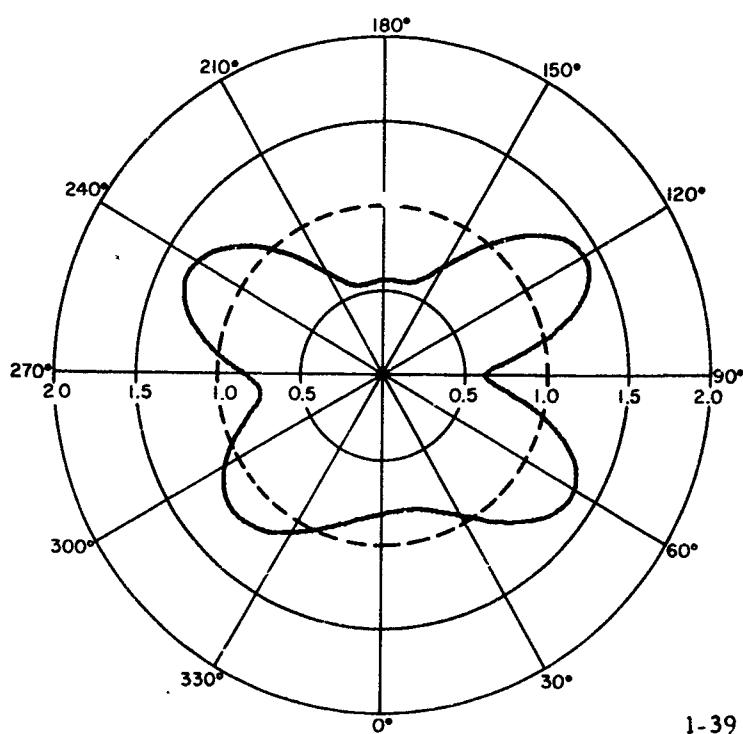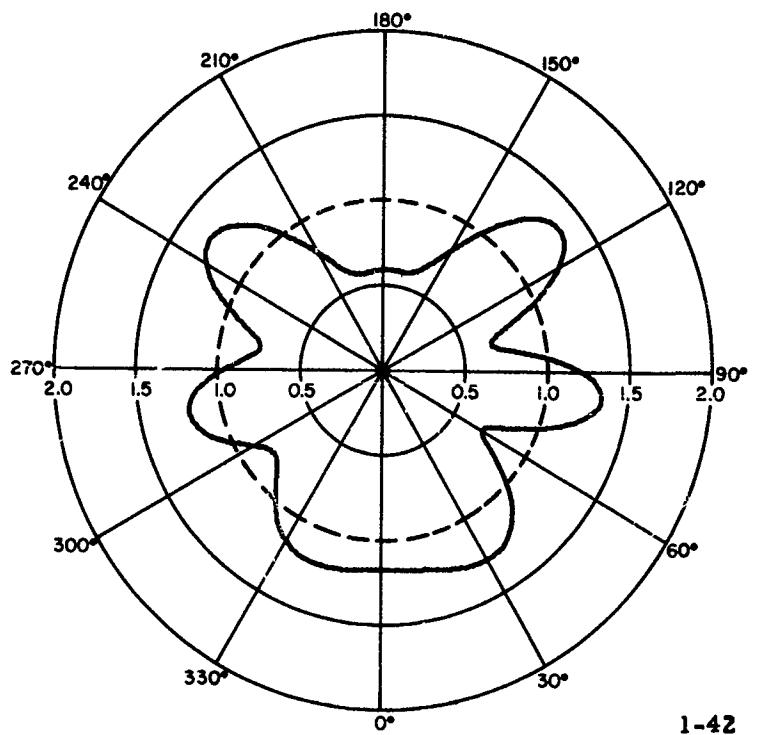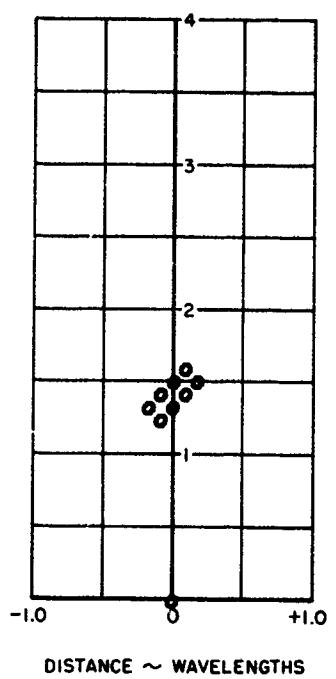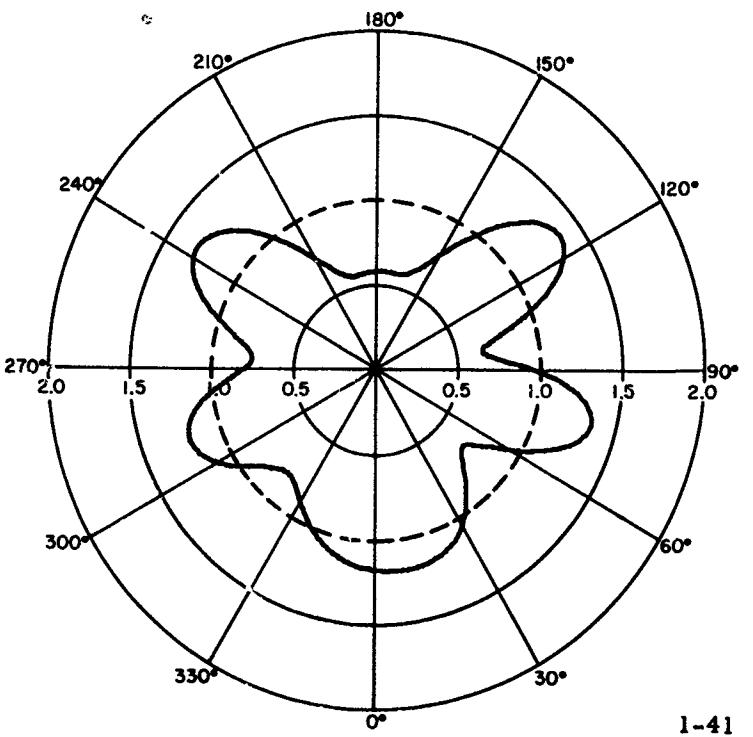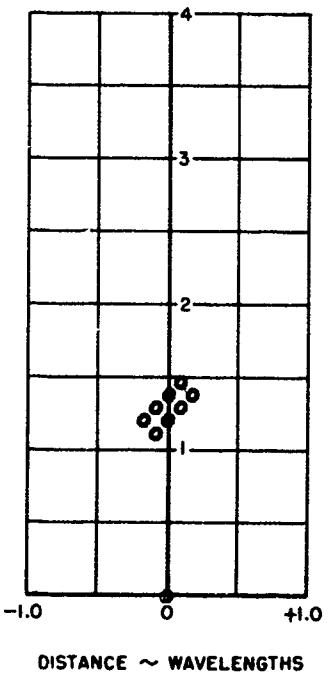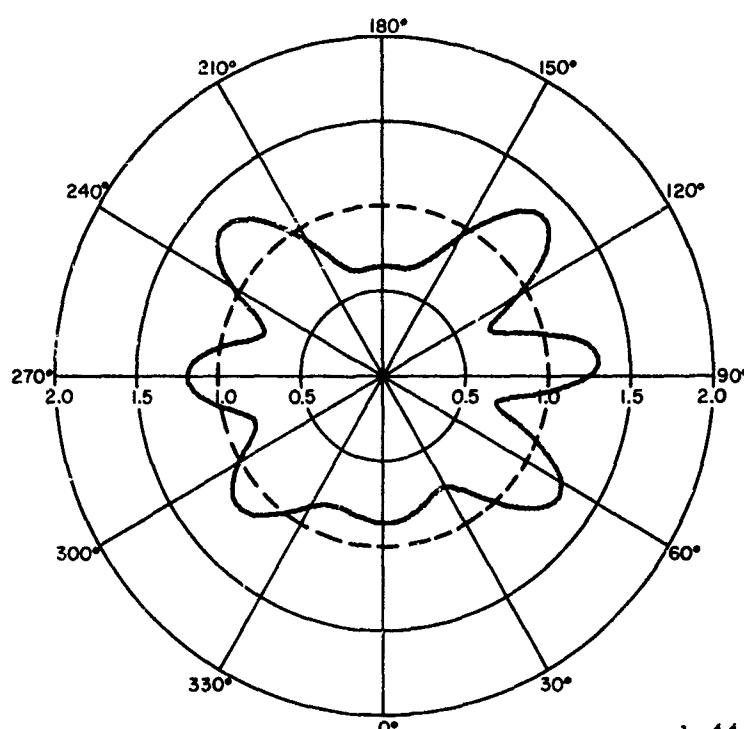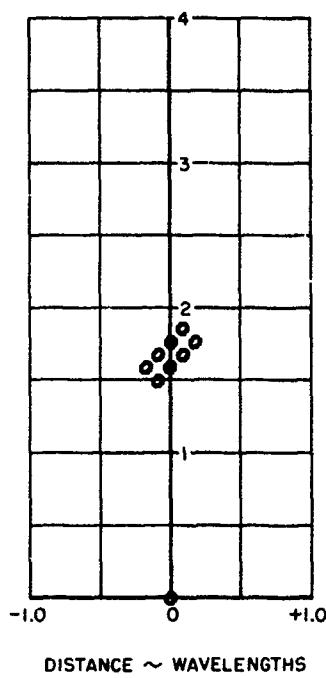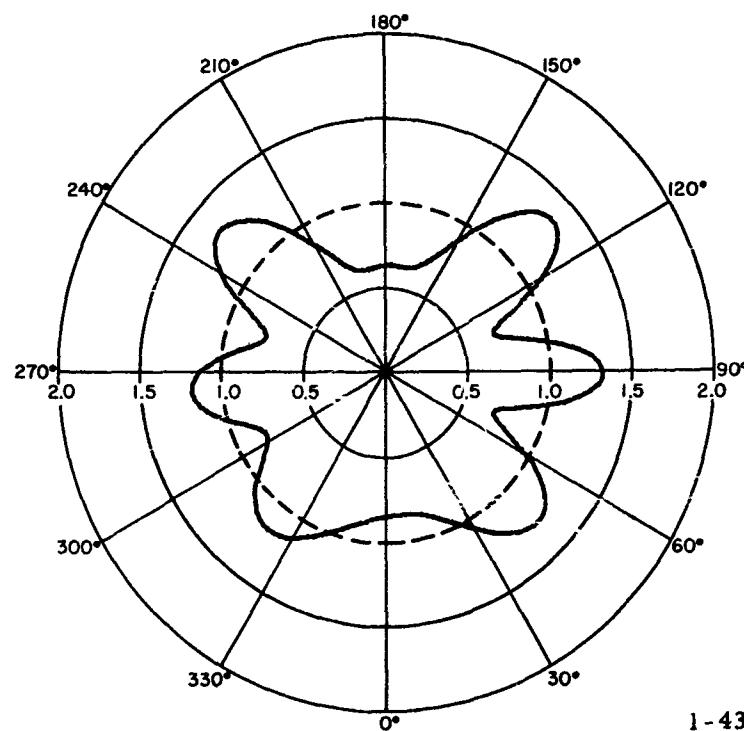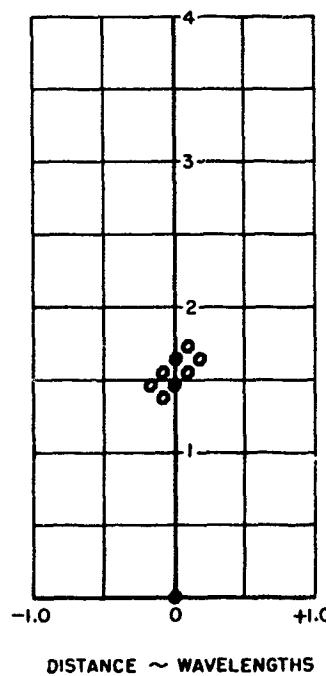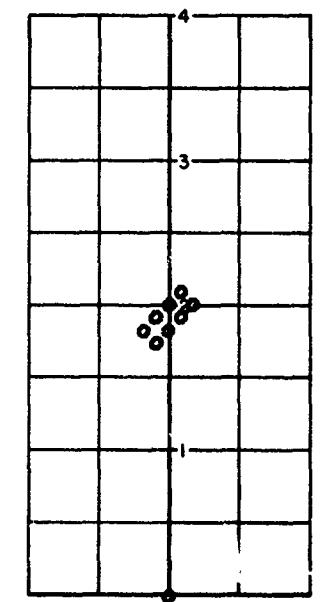
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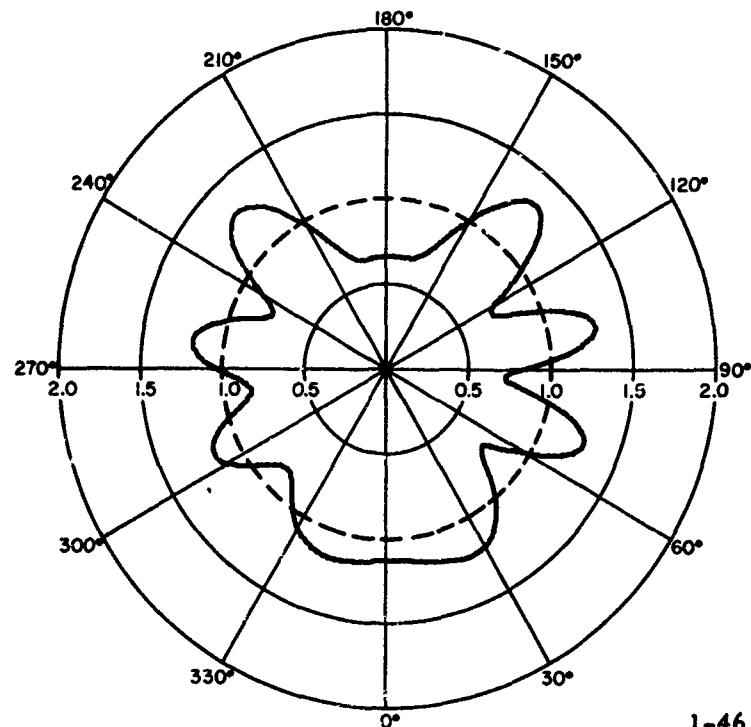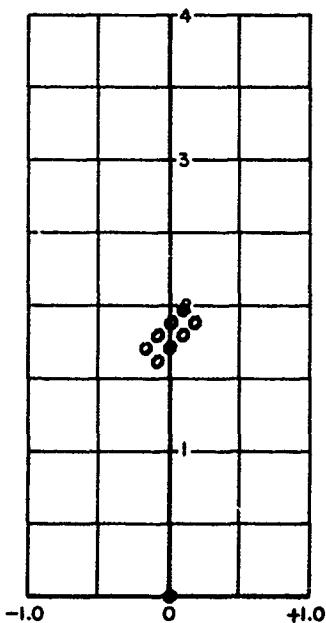
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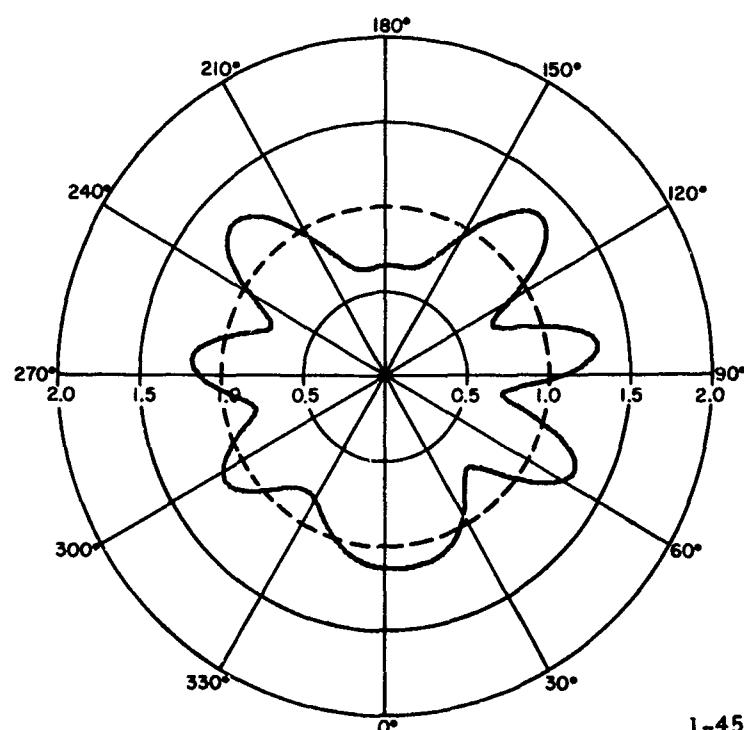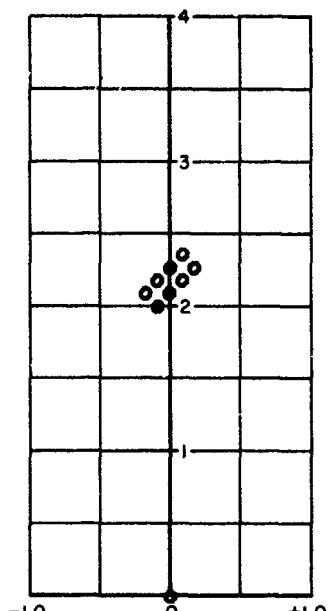
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DISTANCE ~ WAVELENGTHS

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DISTANCE ~ WAVELENGTHS

1-51

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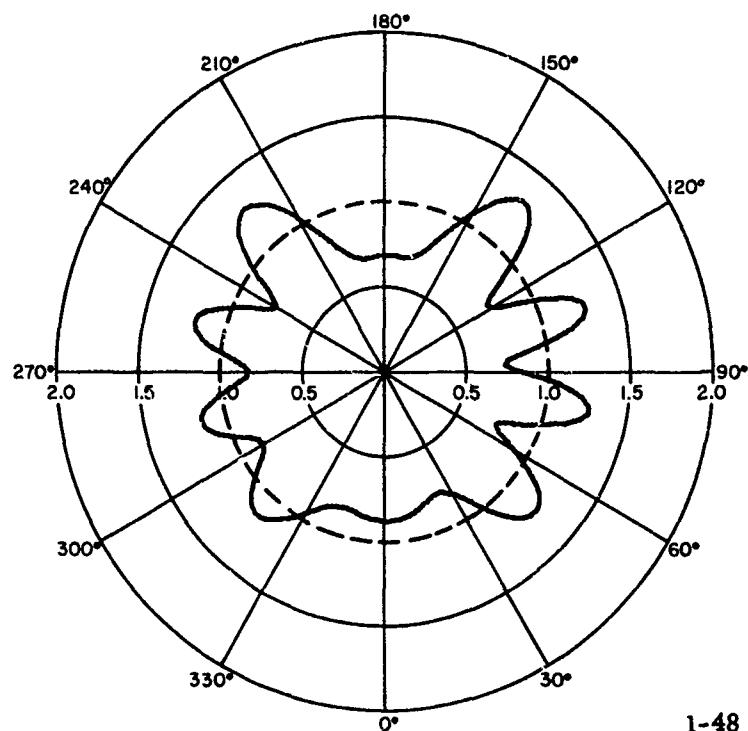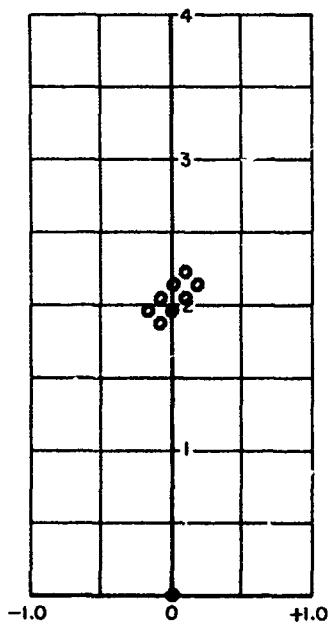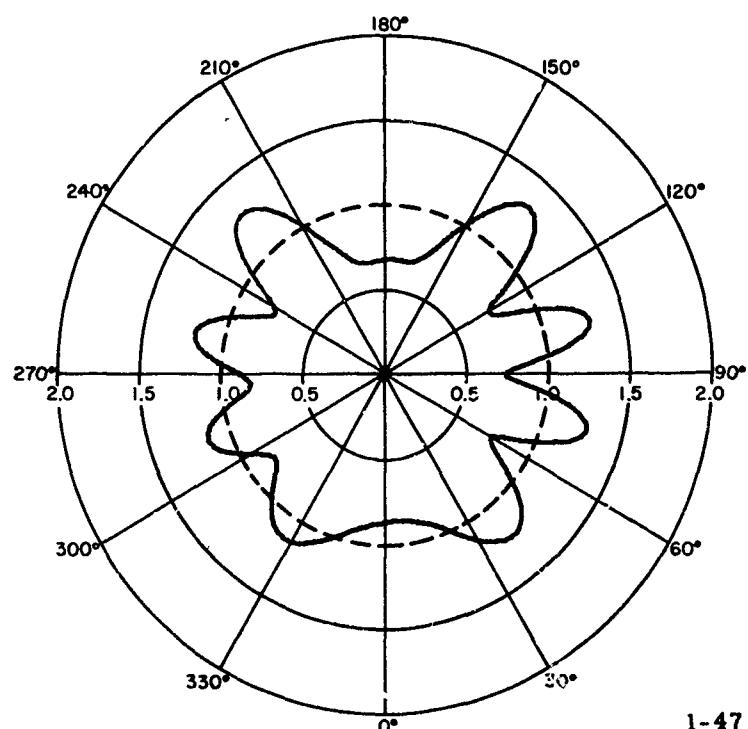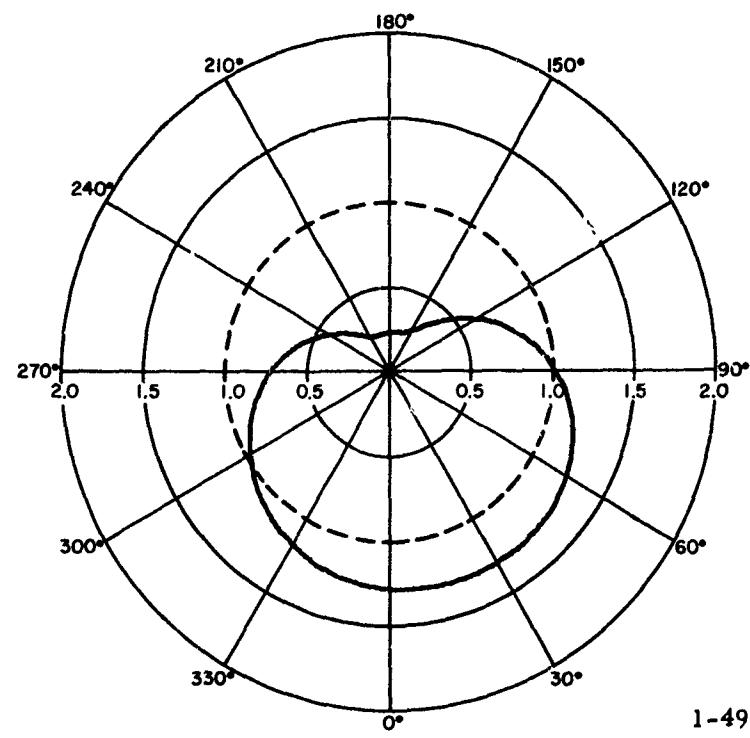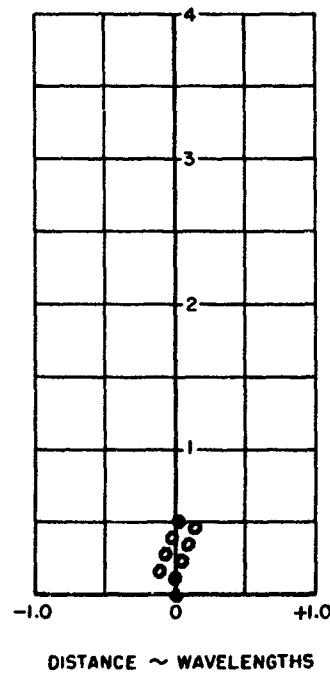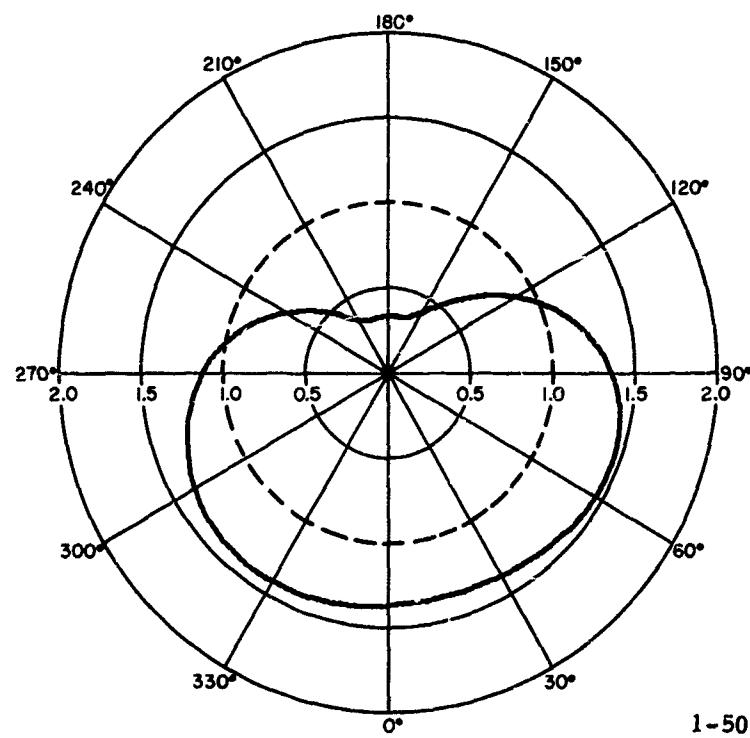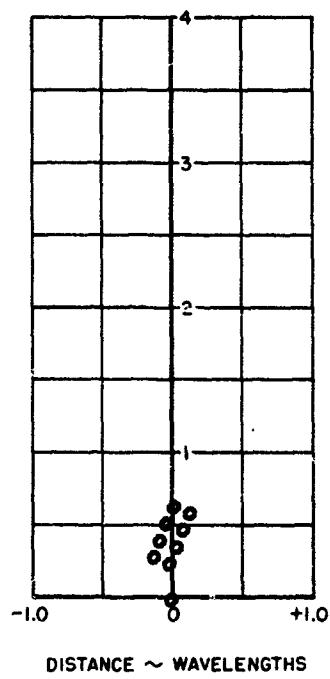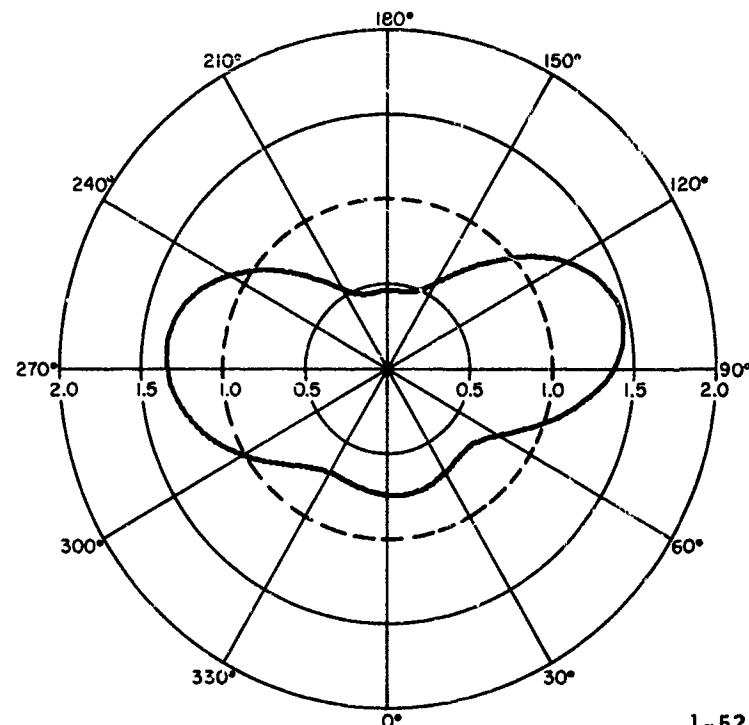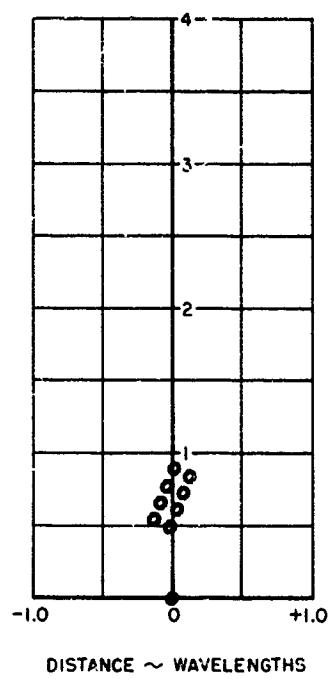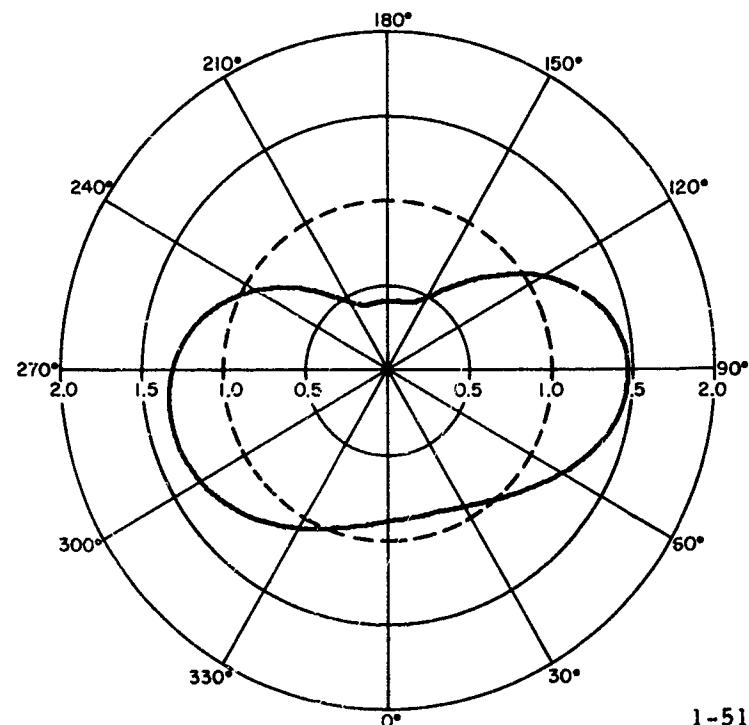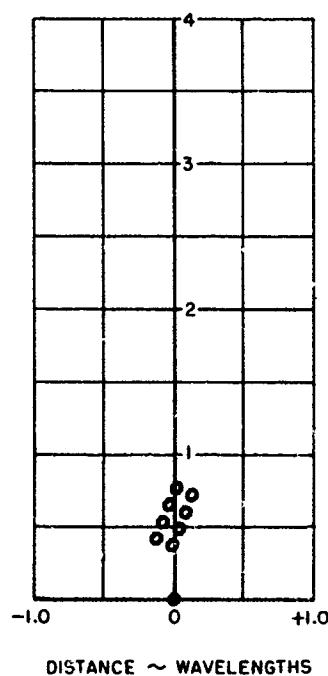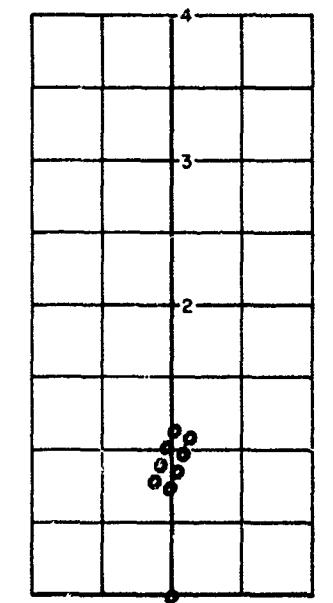
DISTANCE ~ WAVELENGTHS

1-54

DISTANCE ~ WAVELENGTHS

1-53

27

DISTANCE ∼ WAVELENGTHS

1-56

DISTANCE ∼ WAVELENGTHS

1-55

28
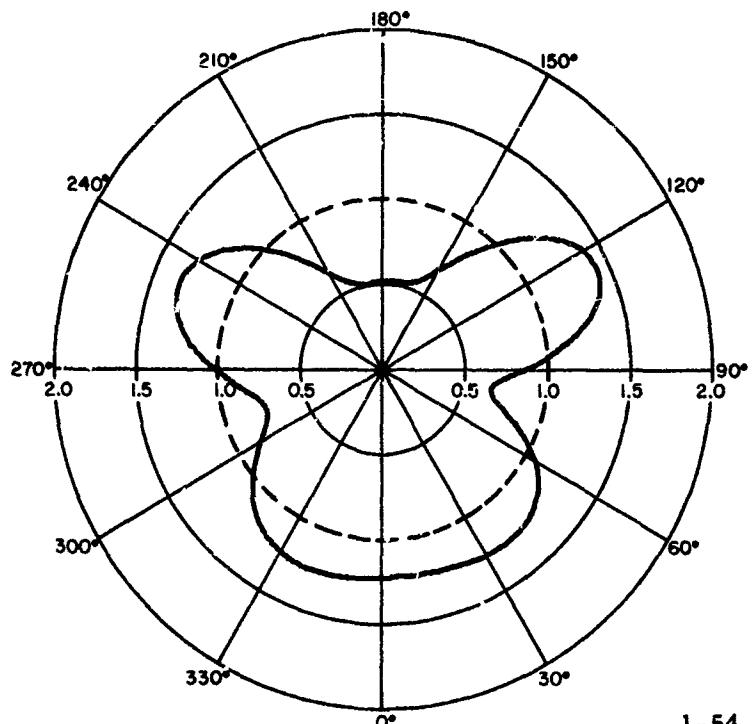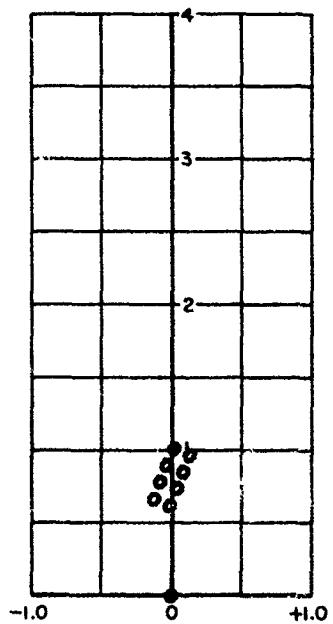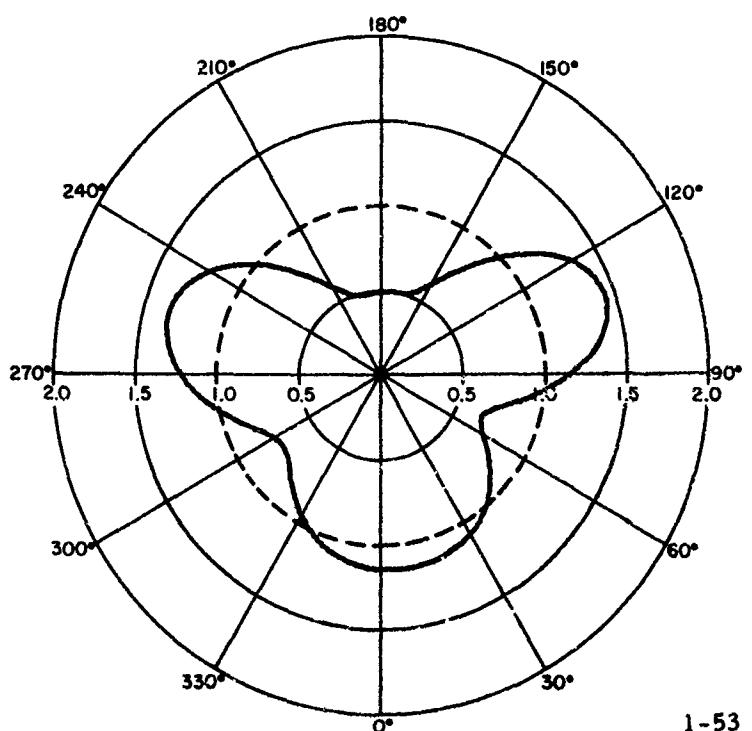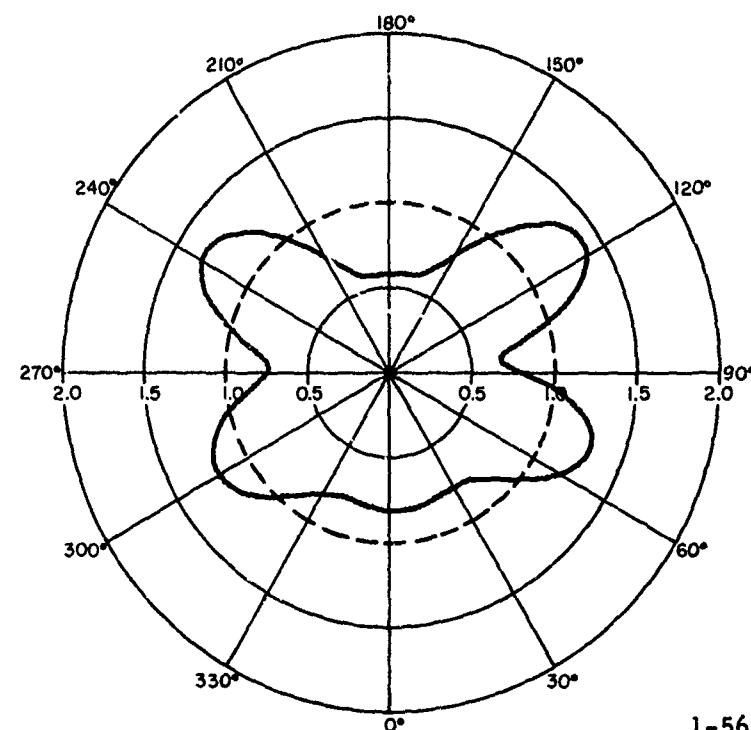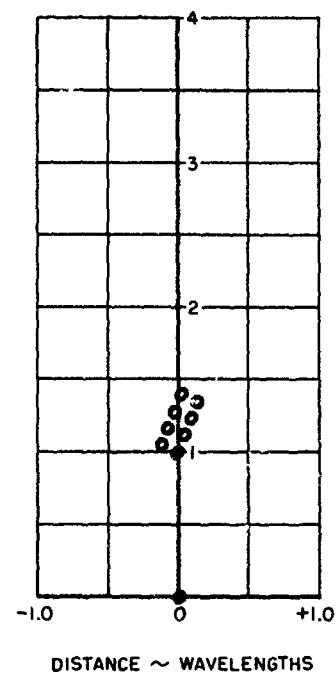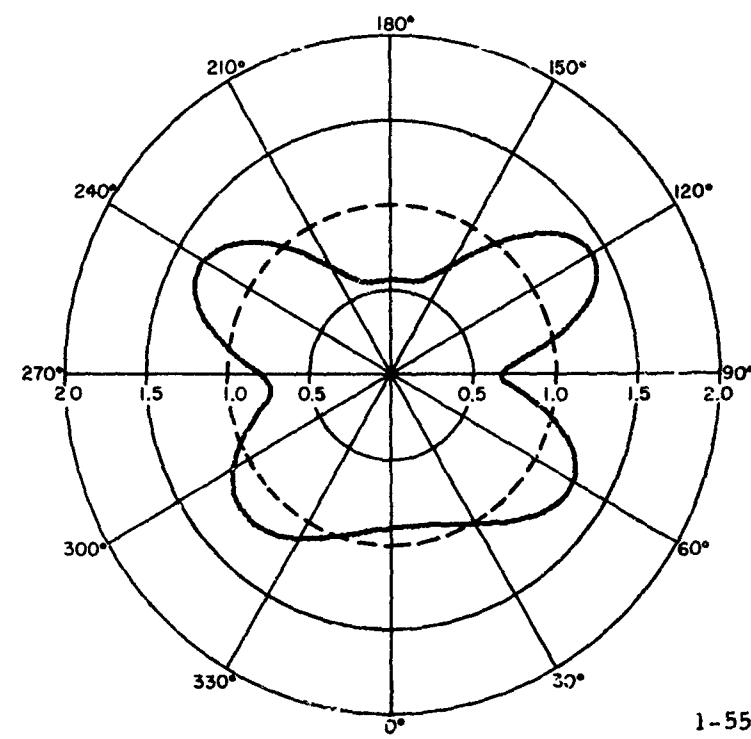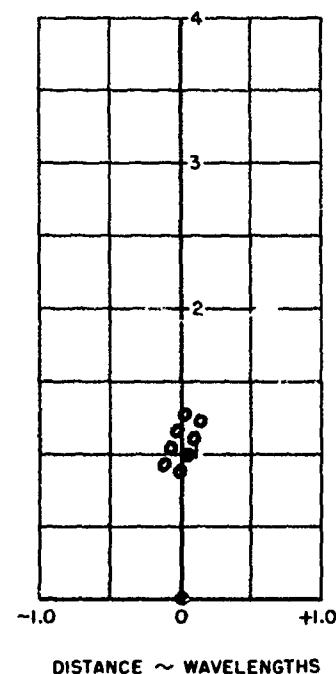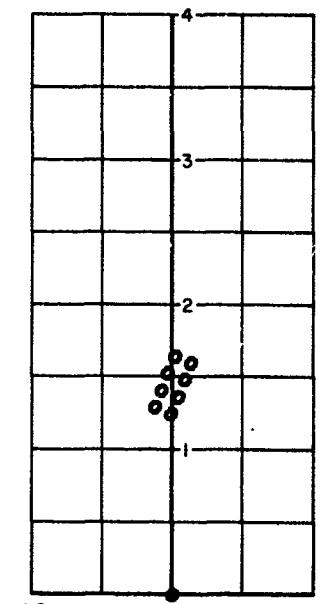
DISTANCE ~ WAVELENGTHS

1-58

DISTANCE ~ WAVELENGTHS

1-57

29

DISTANCE ~ WAVELENGTHS

1-60

DISTANCE ~ WAVELENGTHS

1-59

30

DISTANCE ~ WAVELENGTHS

1-62

DISTANCE ~ WAVELENGTHS

1-61

31

DISTANCE ~ WAVELENGTHS

1-64

DISTANCE ~ WAVELENGTHS

1-63

32
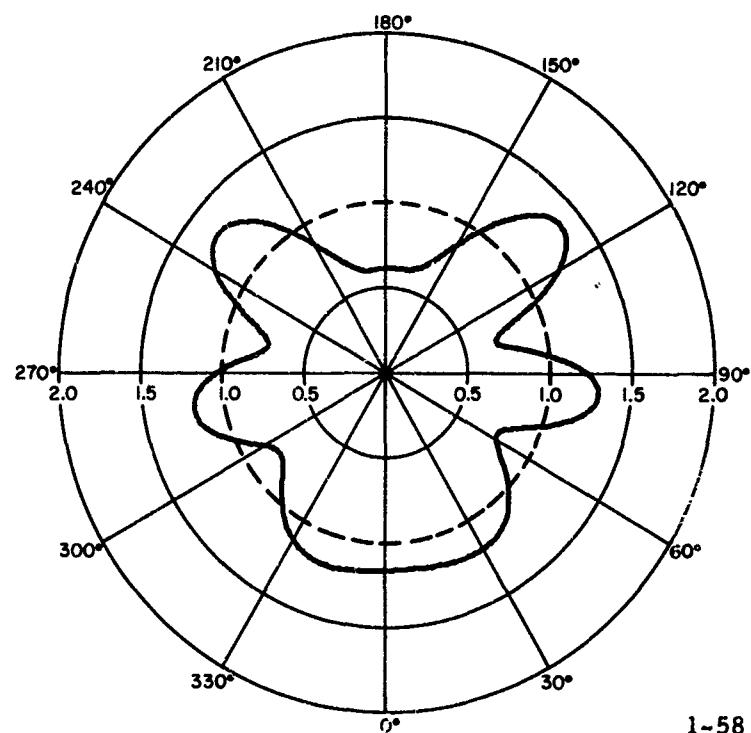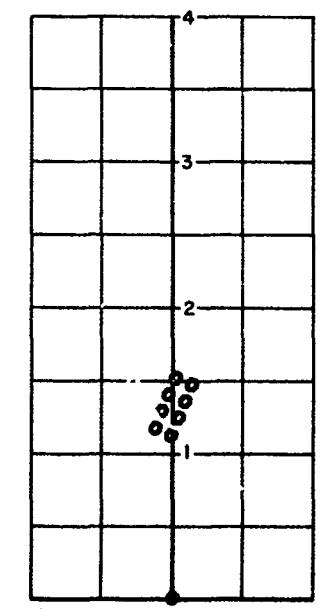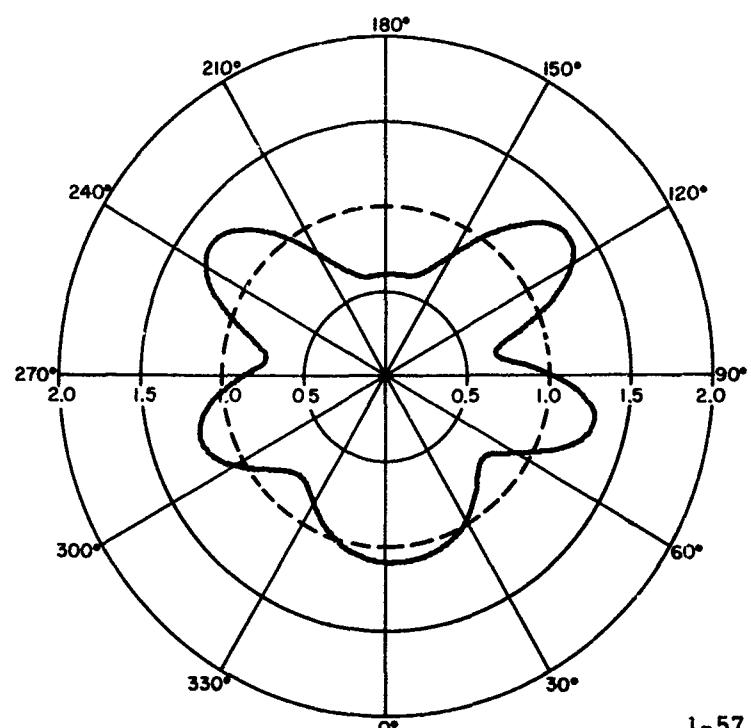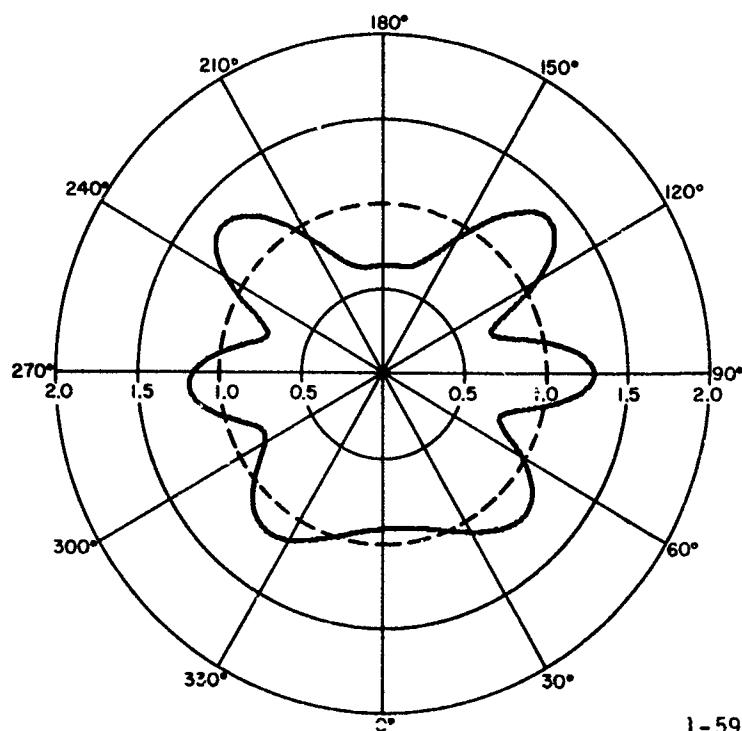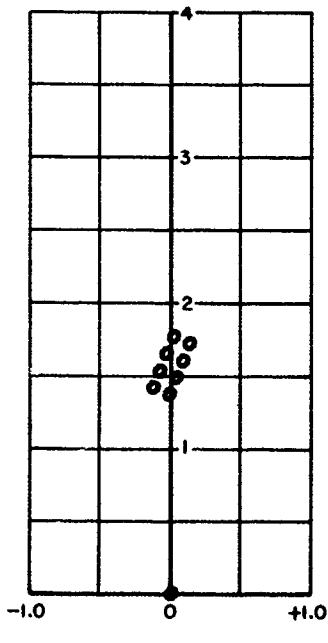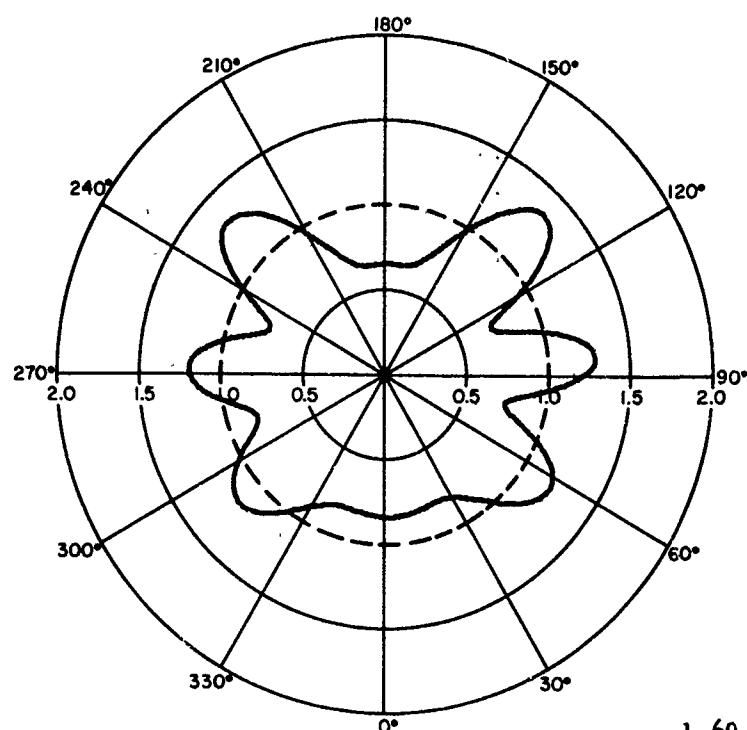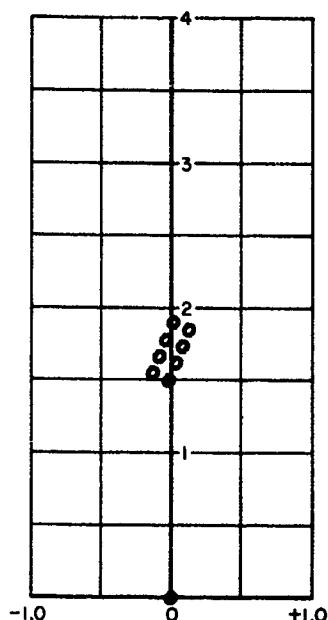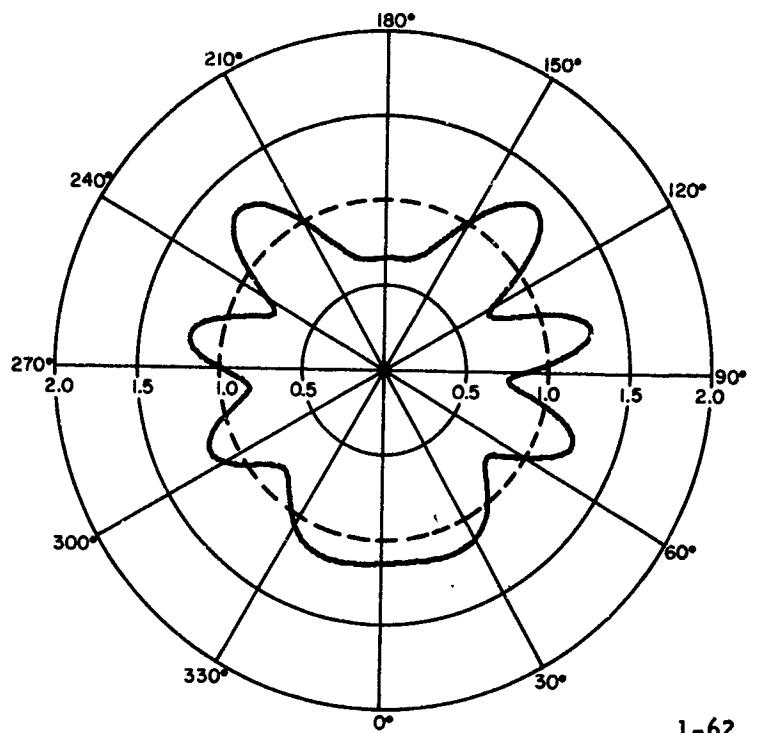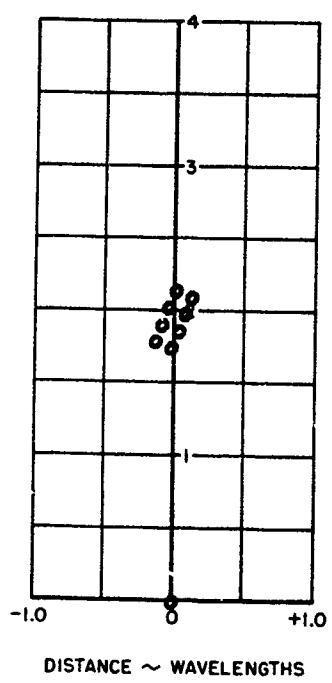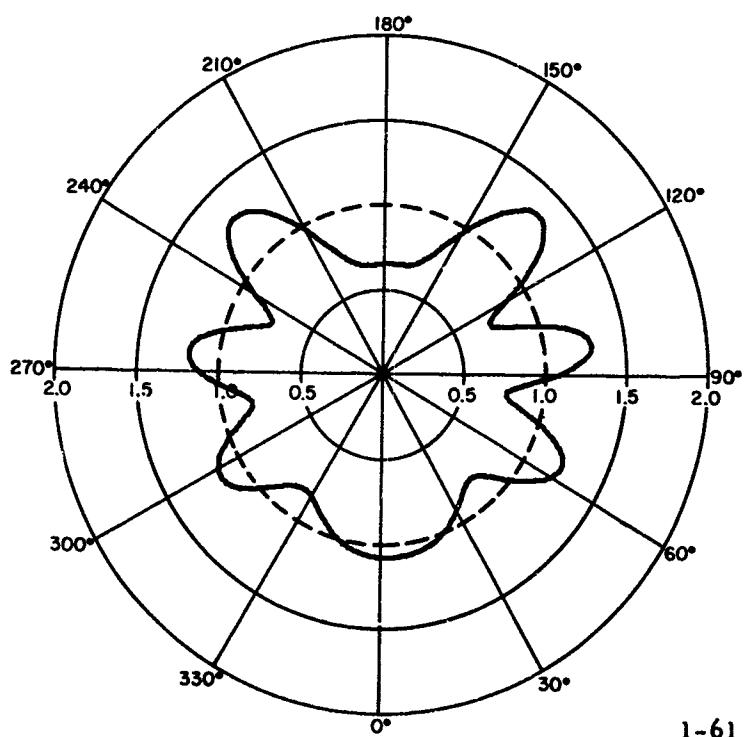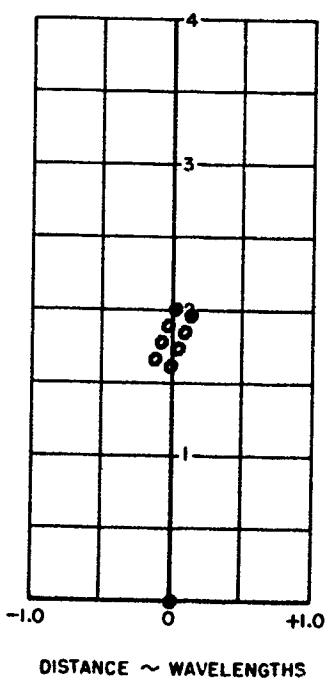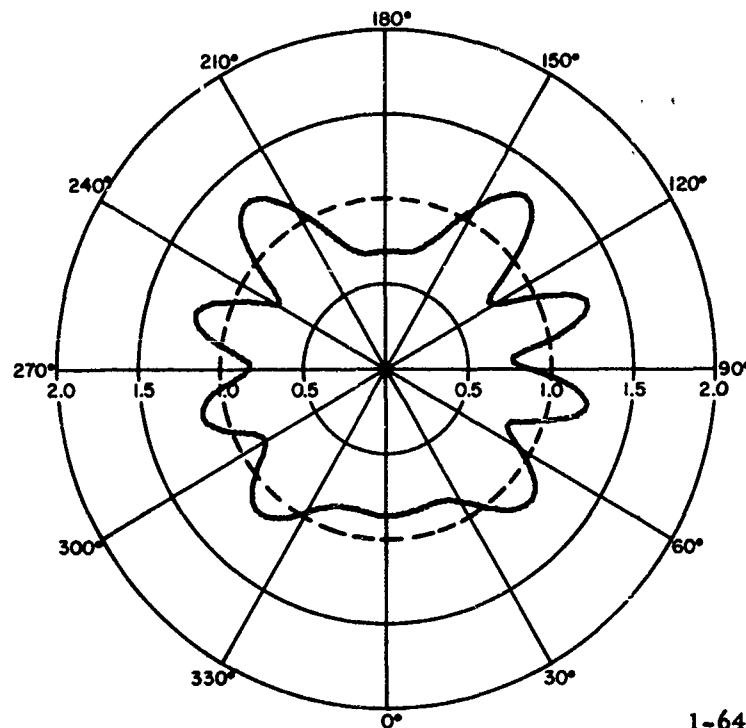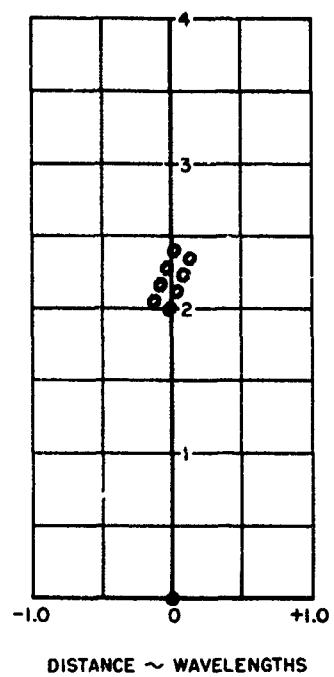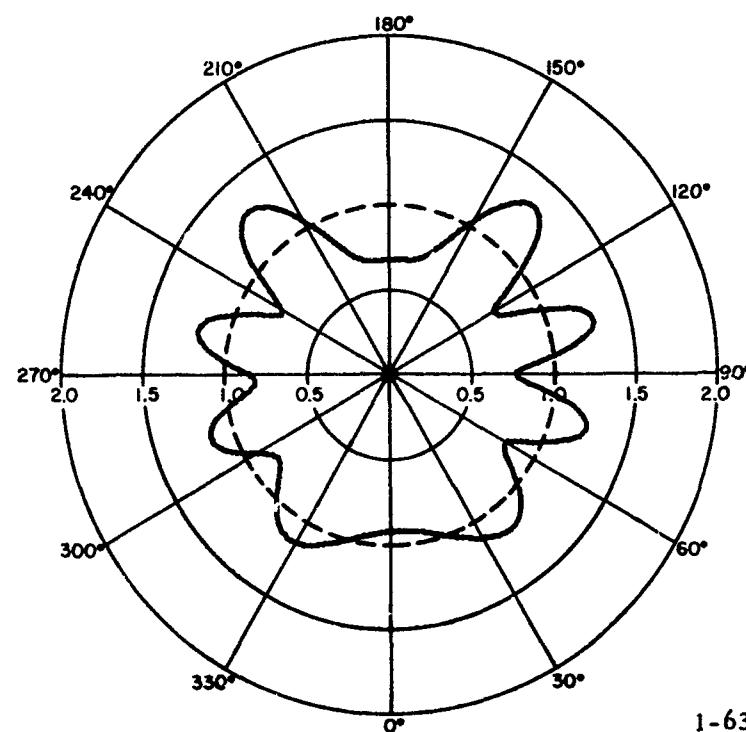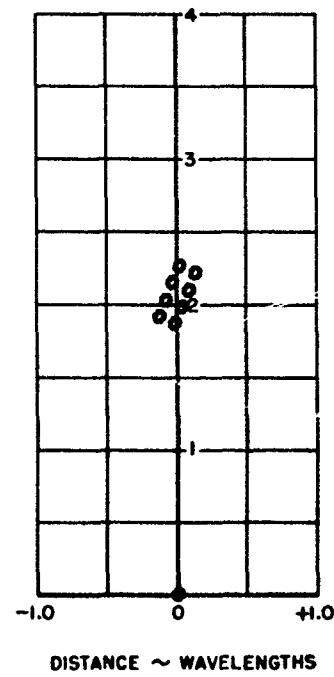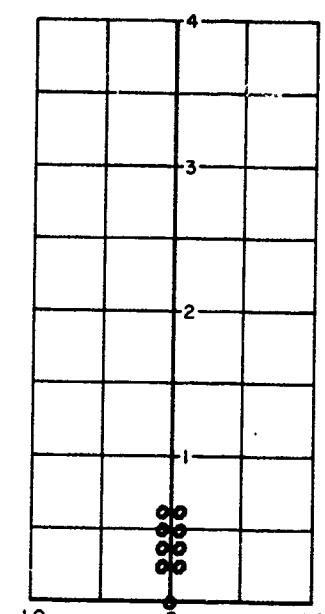
DISTANCE ~ WAVELENGTHS

1-66

DISTANCE ~ WAVELENGTHS
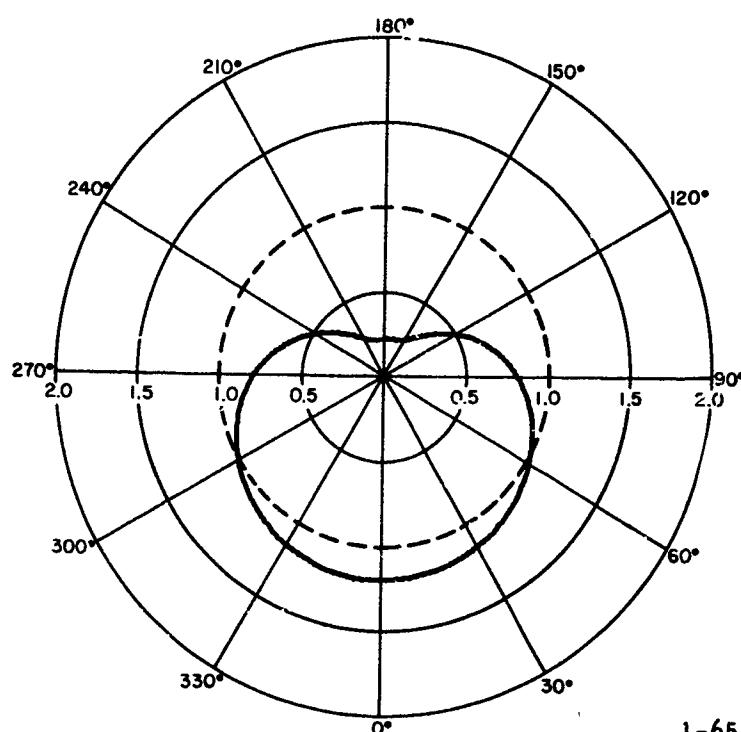
1-65
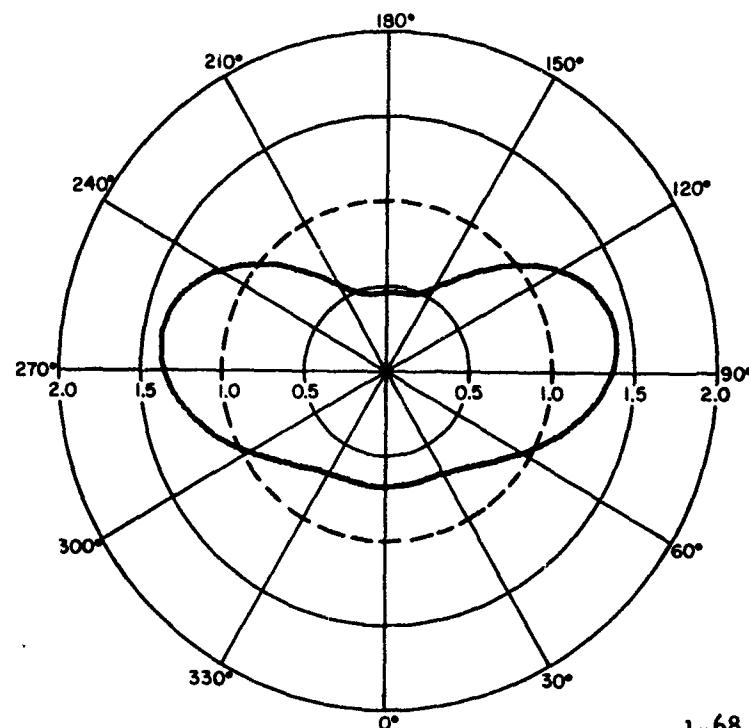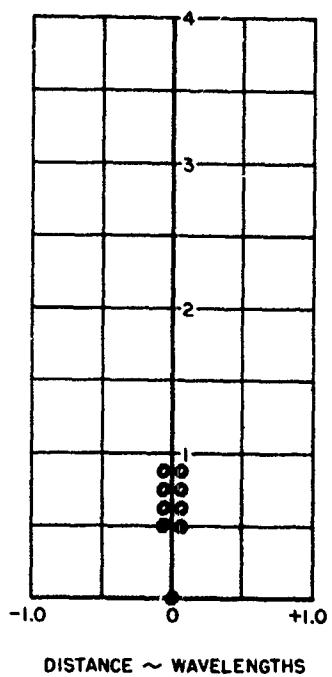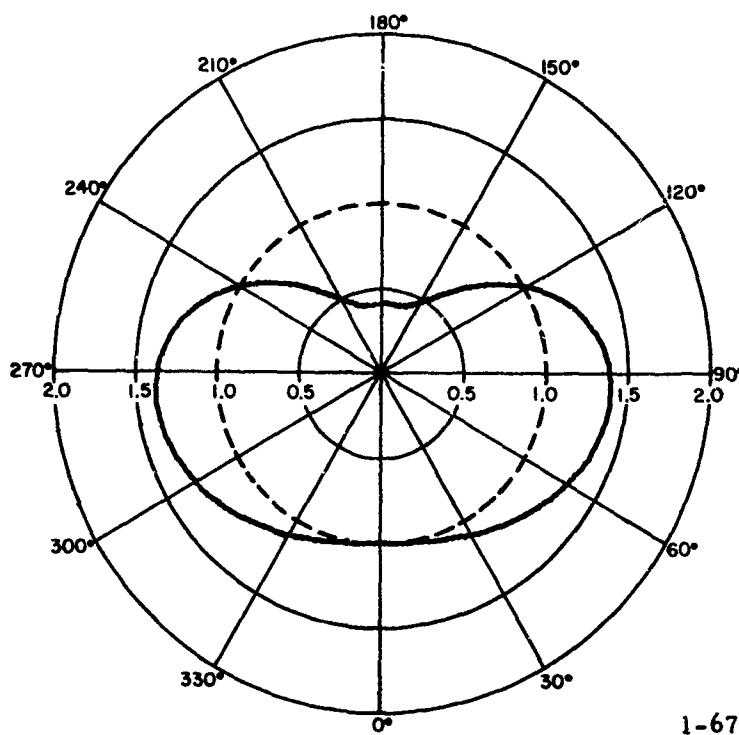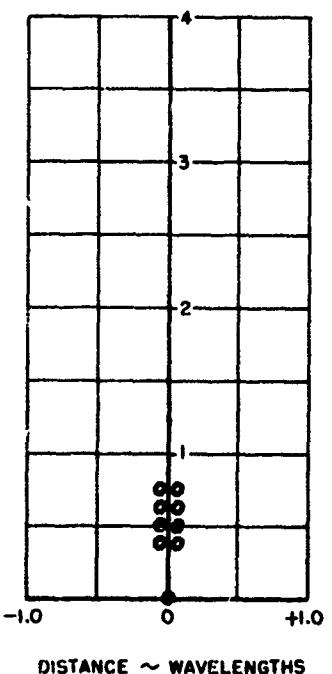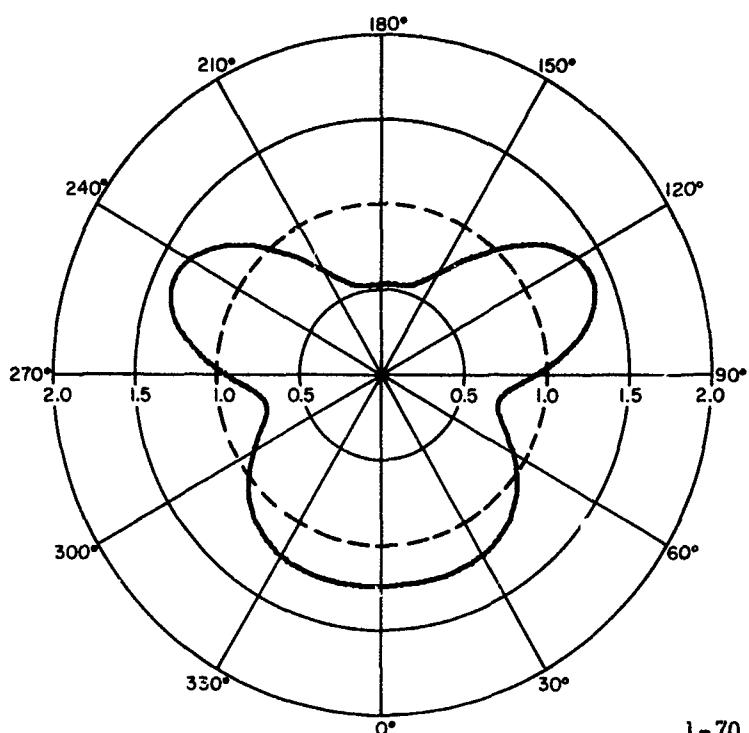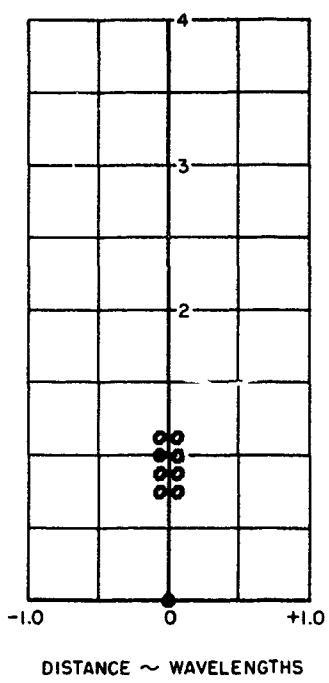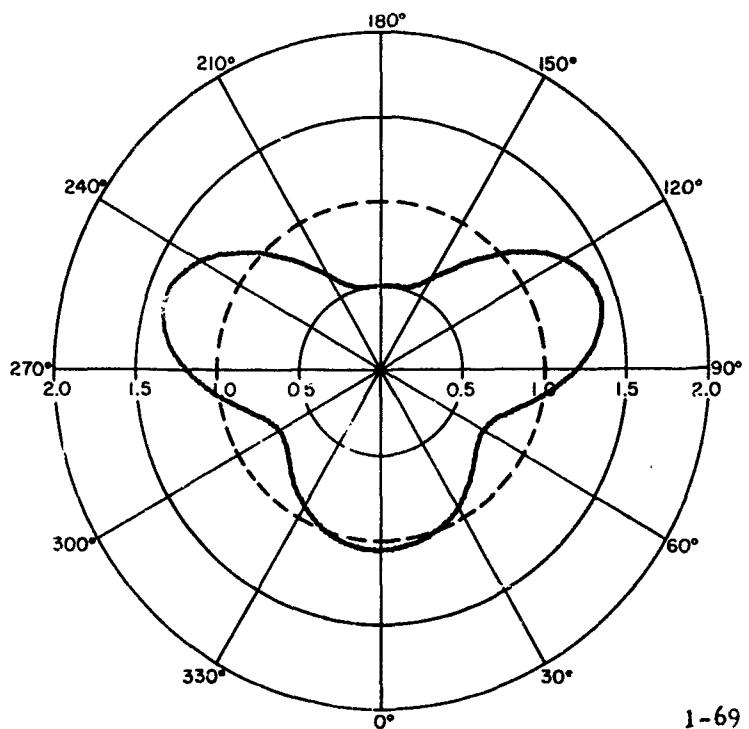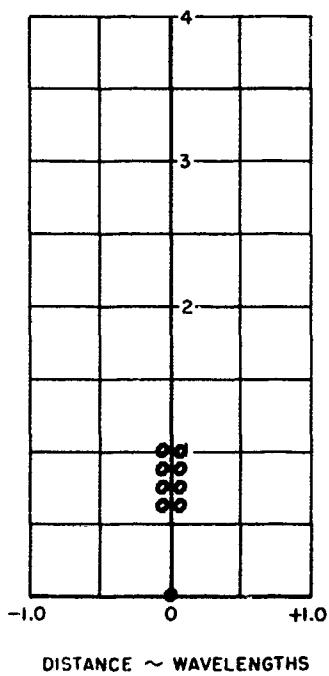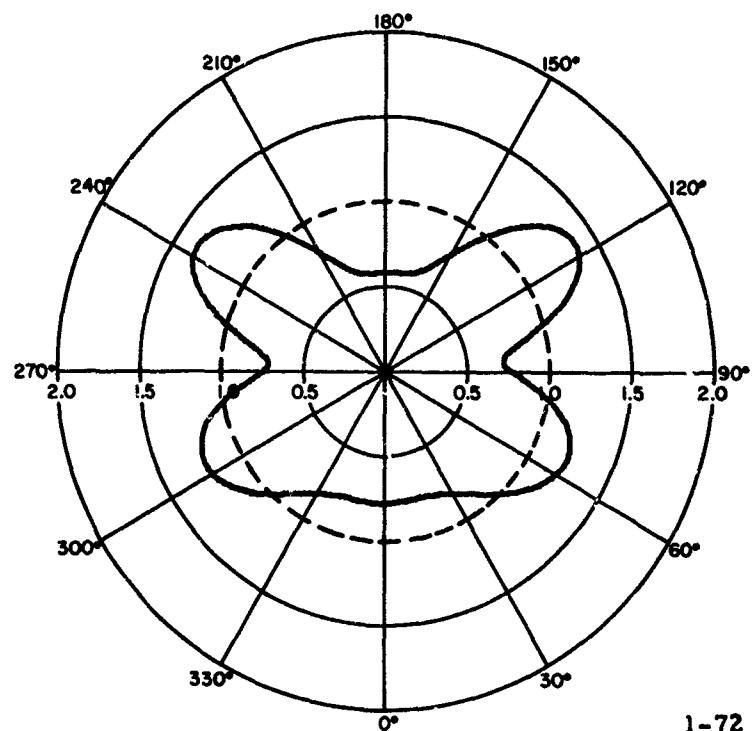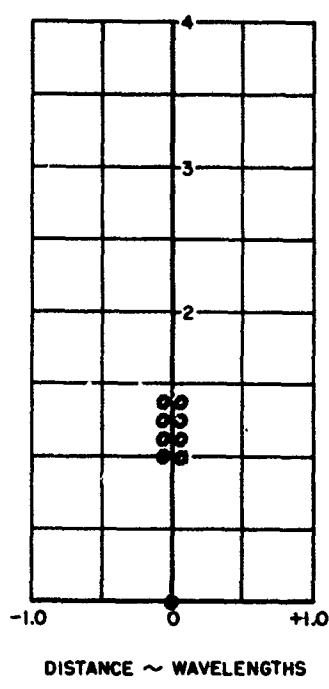
33

DISTANCE ~ WAVELENGTHS

1-68

DISTANCE ~ WAVELENGTHS

1-67

34

DISTANCE ~ WAVELENGTHS

1-70

DISTANCE ~ WAVELENGTHS

1-69

35

DISTANCE ~ WAVELENGTHS

1-72

DISTANCE ~ WAVELENGTHS

1-71

36

DISTANCE ~ WAVELENGTHS

1-74

DISTANCE ~ WAVELENGTHS

1-73

37

DISTANCE ~ WAVELENGTHS

1-76

DISTANCE ~ WAVELENGTHS

1-75

38
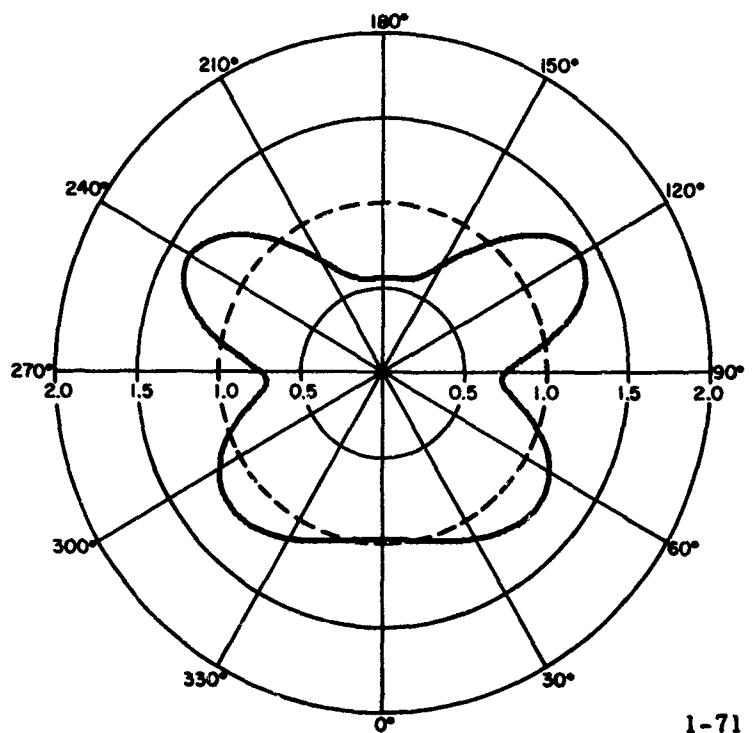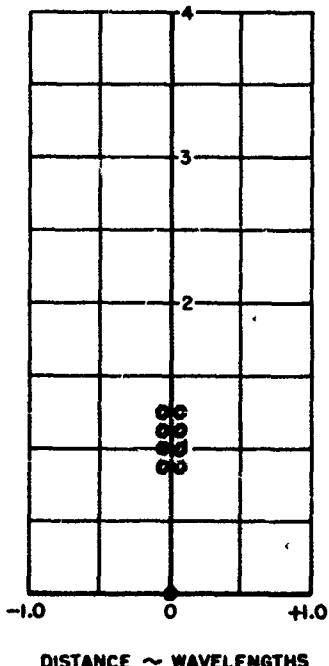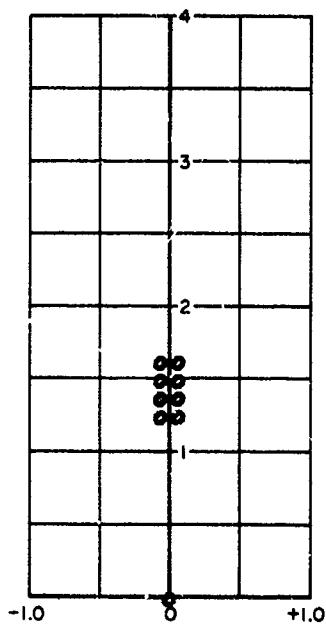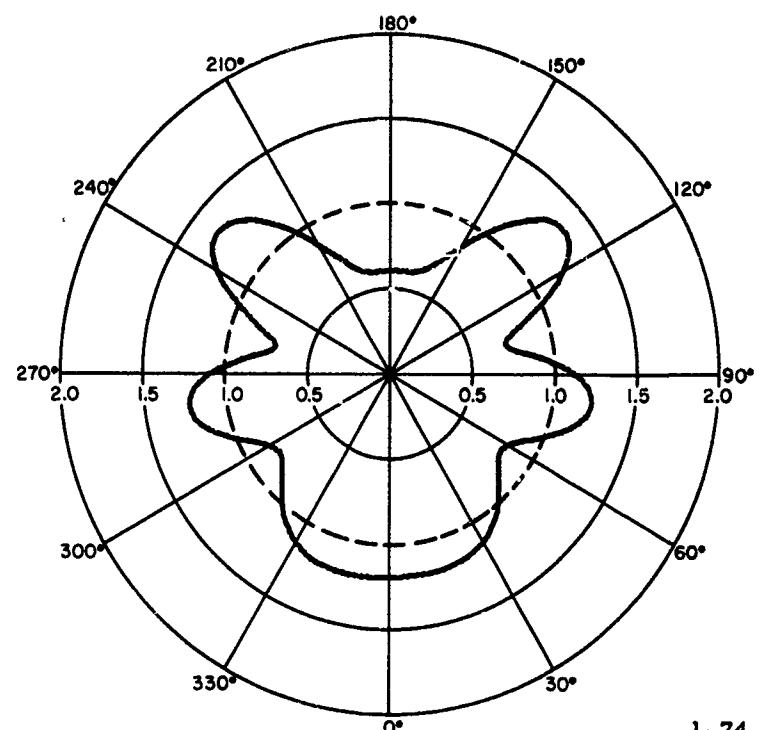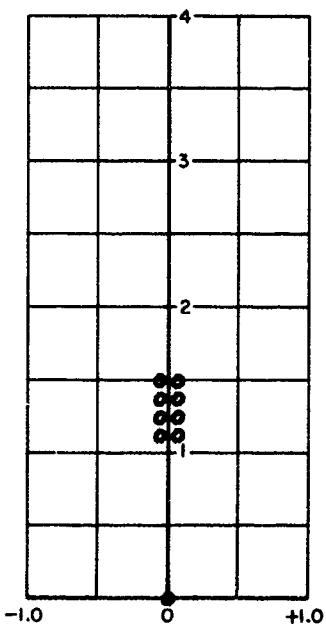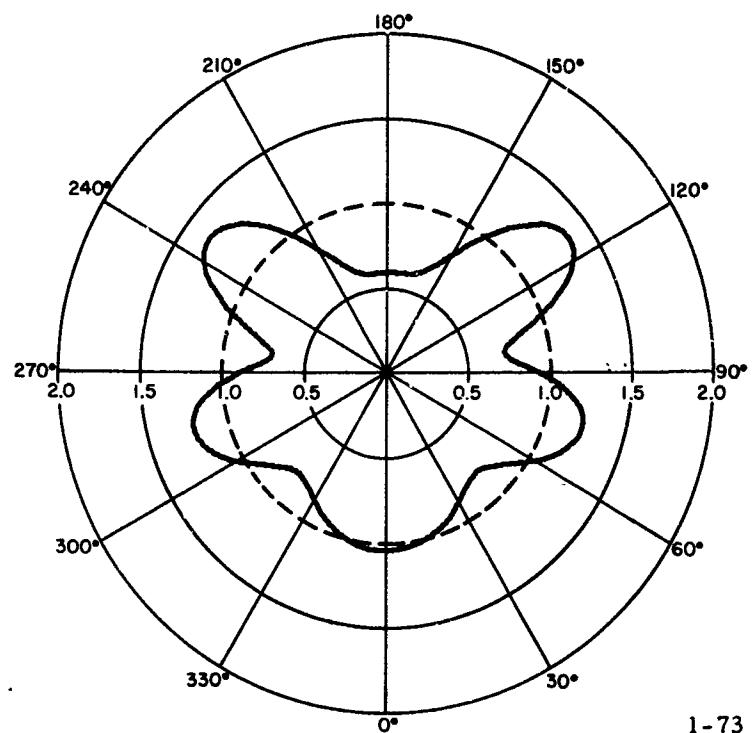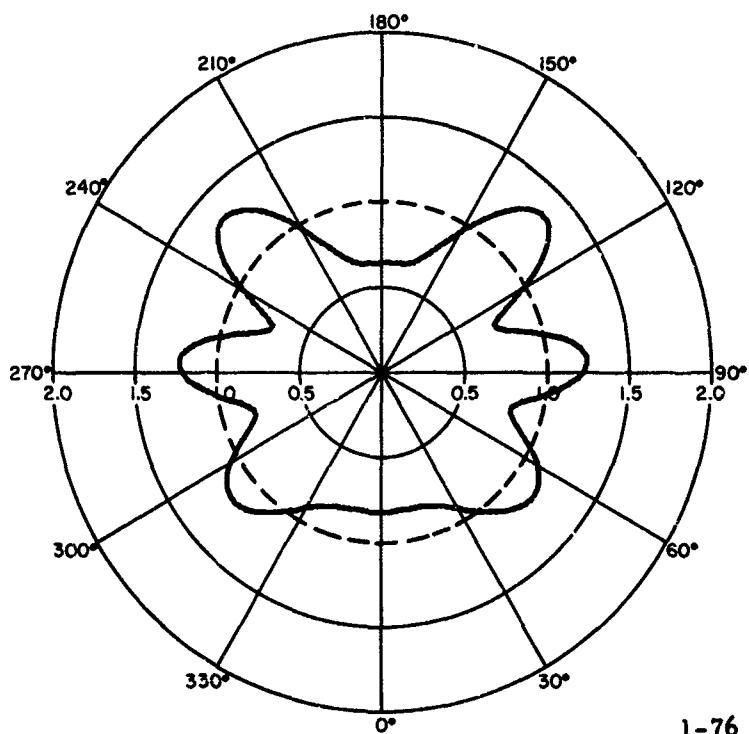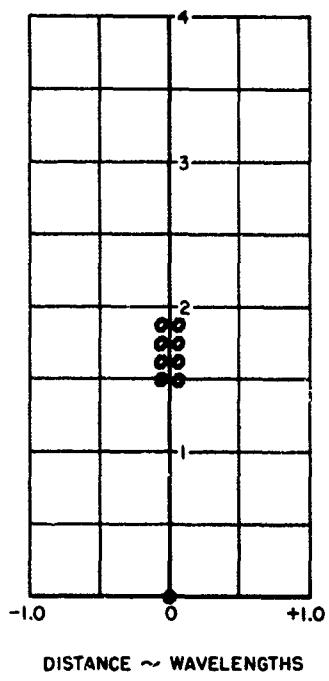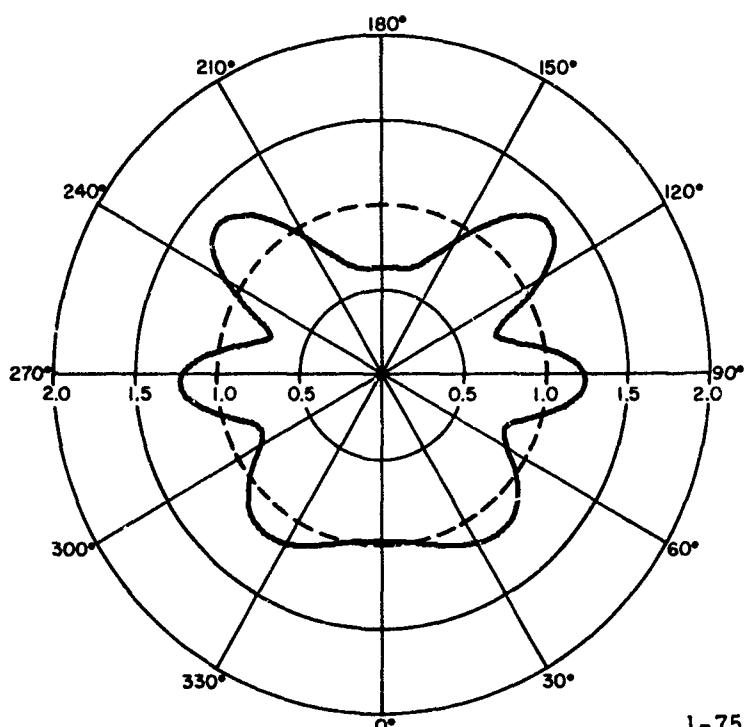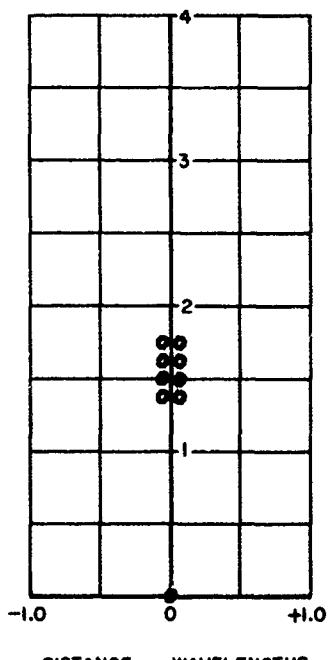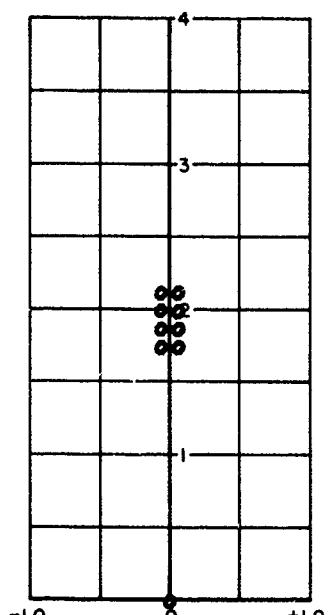
DISTANCE ~ WAVELENGTHS

1-78
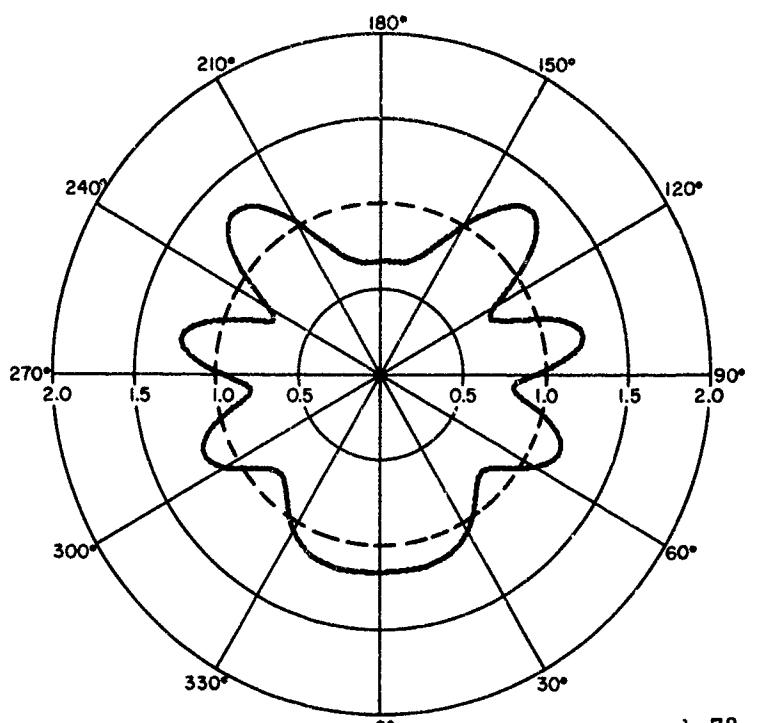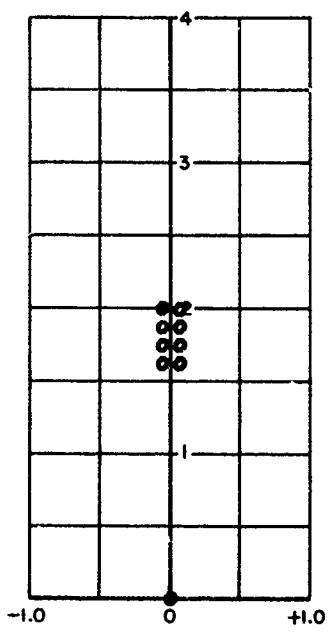
DISTANCE ~ WAVELENGTHS

1-77

39
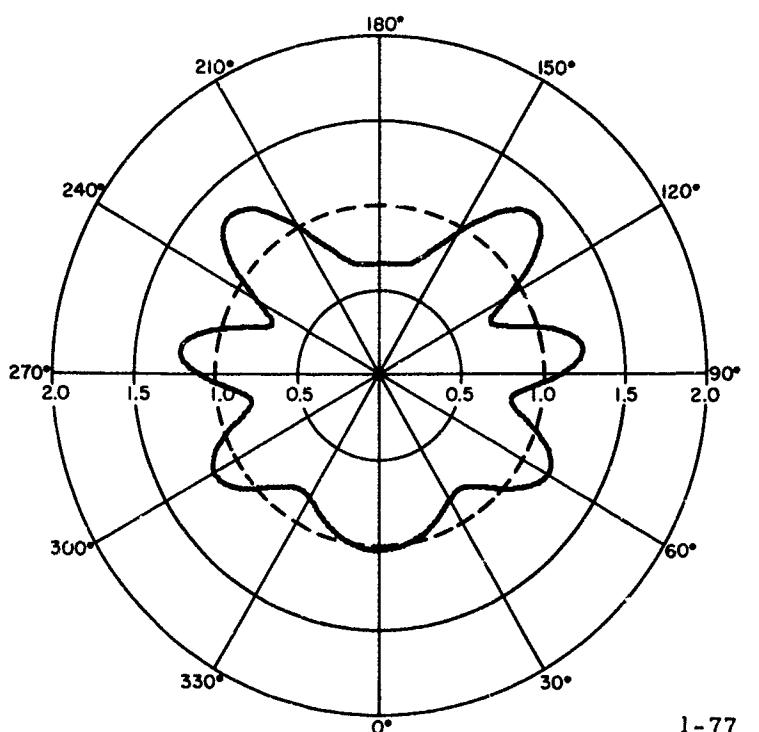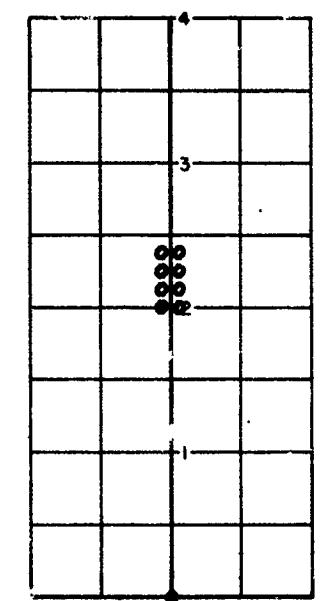
DISTANCE ~ WAVELENGTHS

1-80

DISTANCE ~ WAVELENGTHS

1-79

40

DISTANCE ~ WAVELENGTHS

2-2

DISTANCE ~ WAVELENGTHS

2-1

41

DISTANCE ~ WAVELENGTHS

2-4

DISTANCE ~ WAVELENGTHS

2-3

42
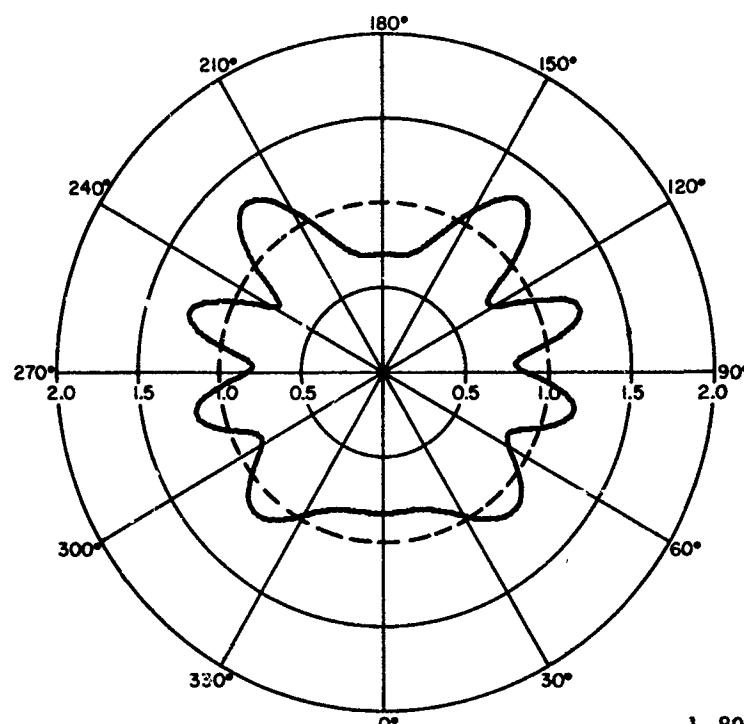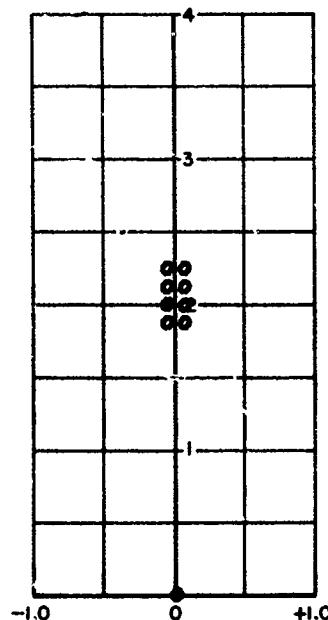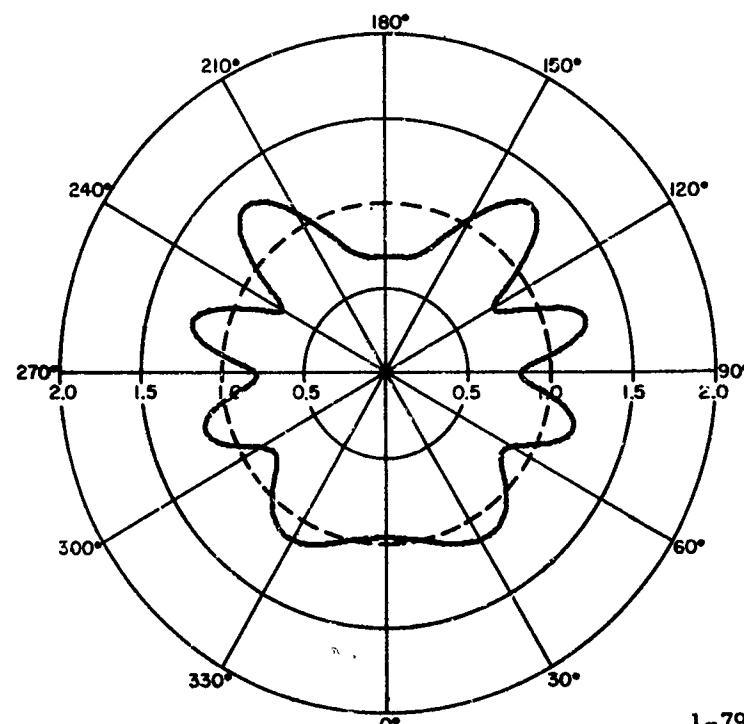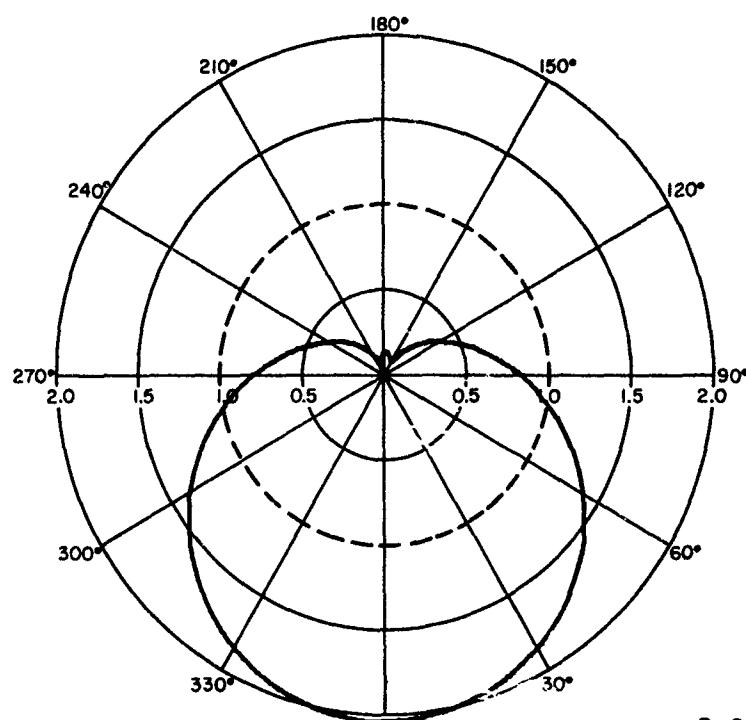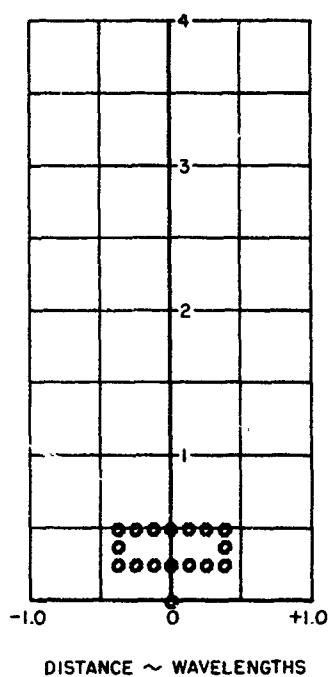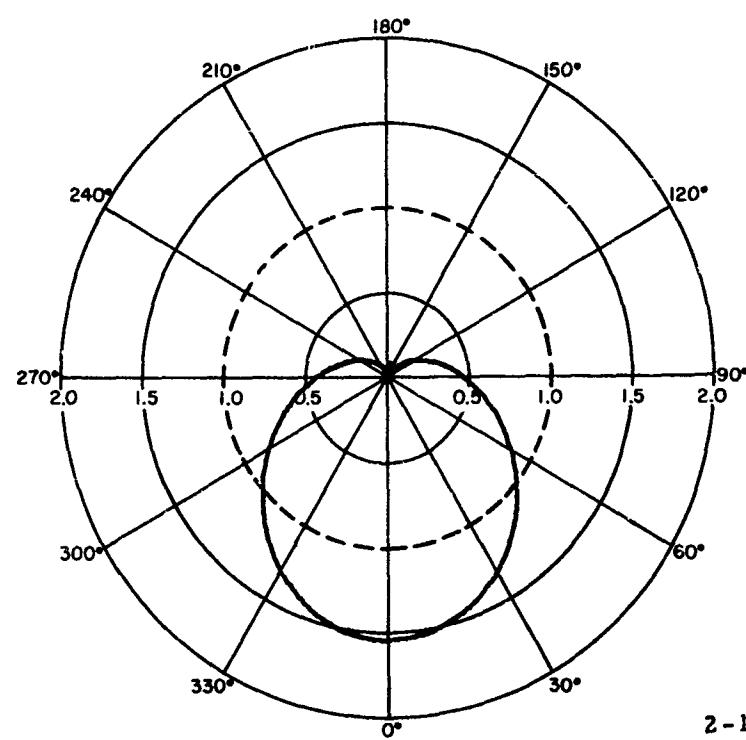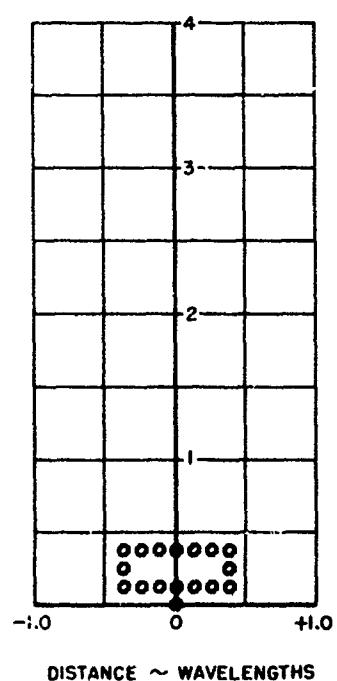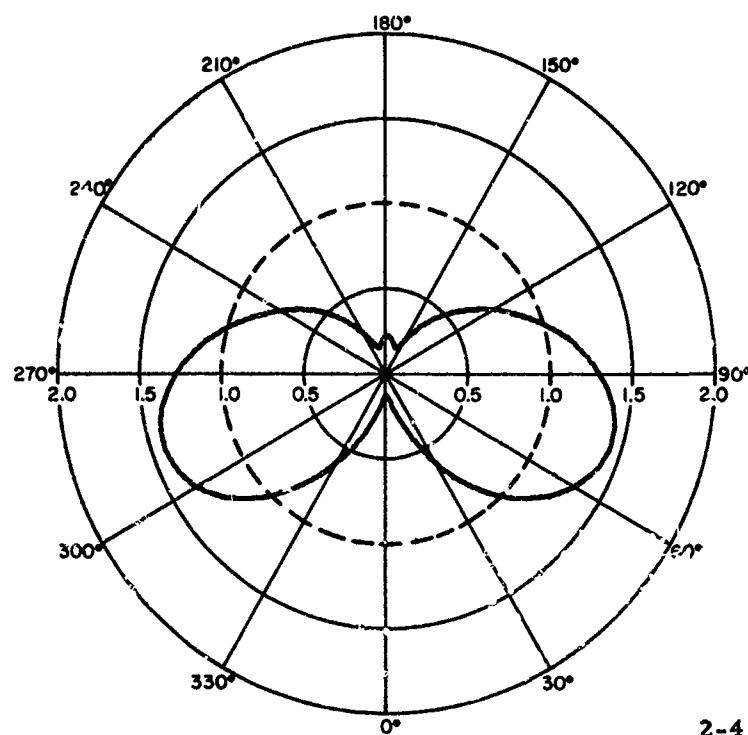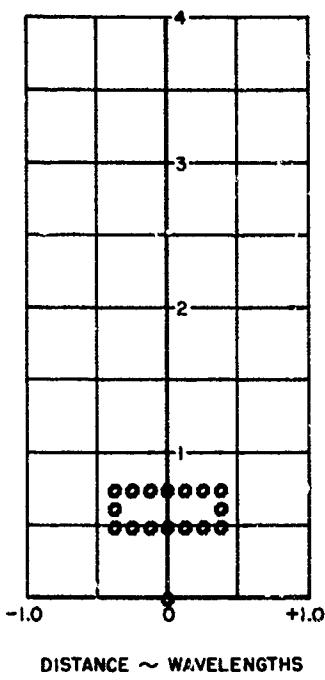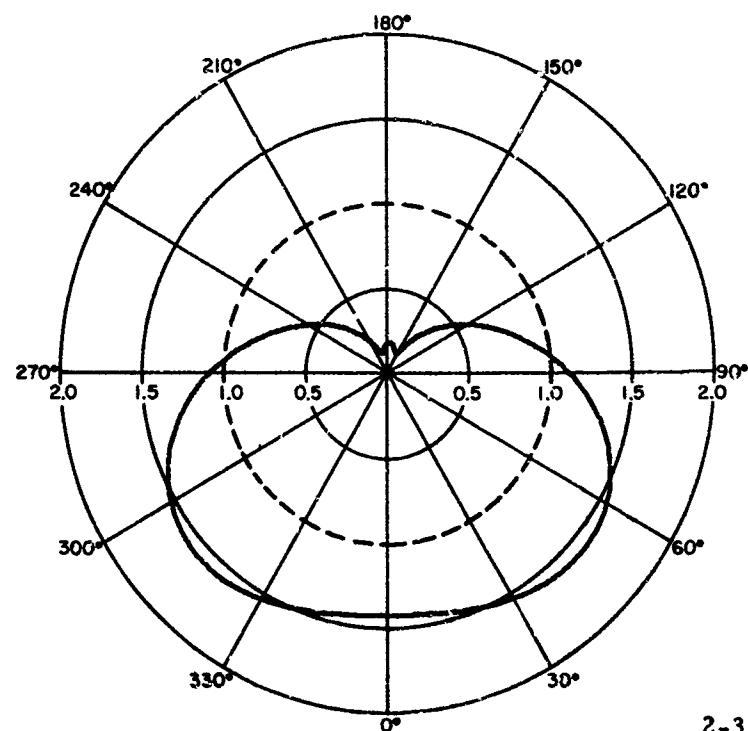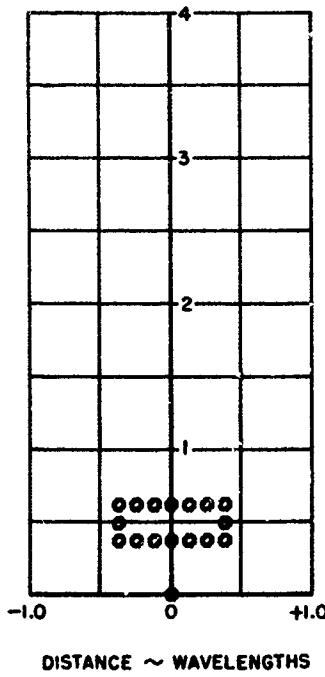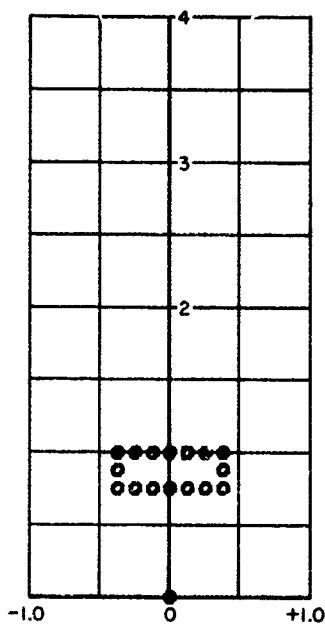
DISTANCE ~ WAVELENGTHS

2-6

DISTANCE ~ WAVELENGTHS

2-5

43
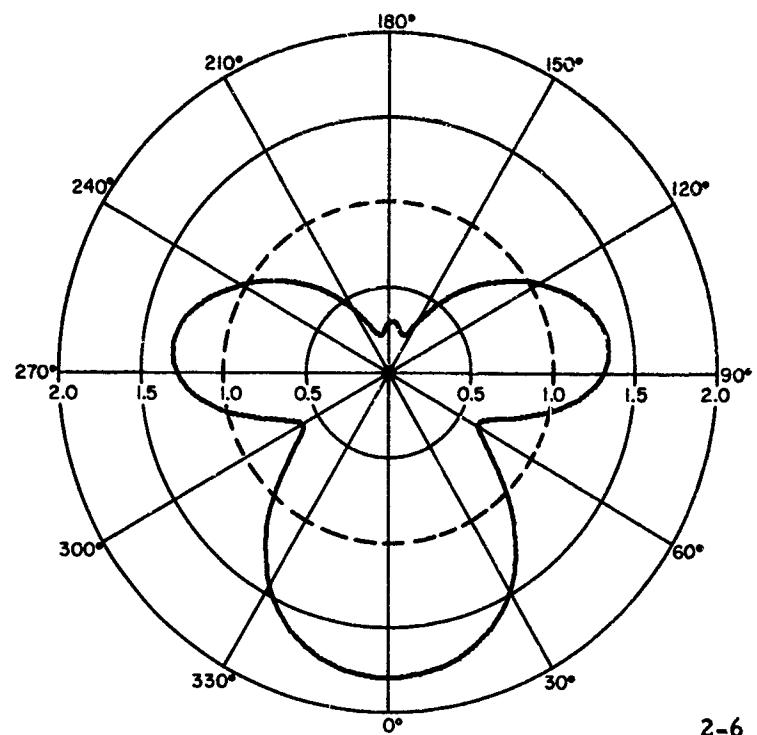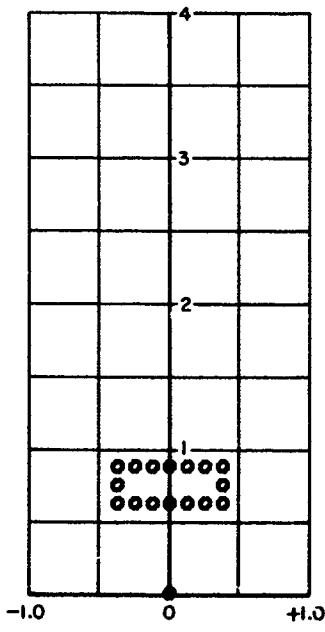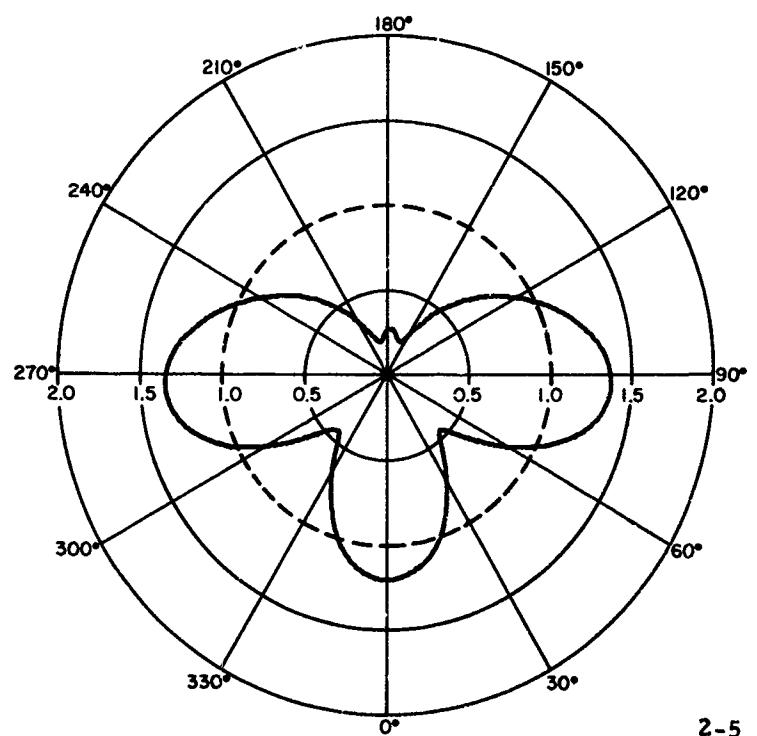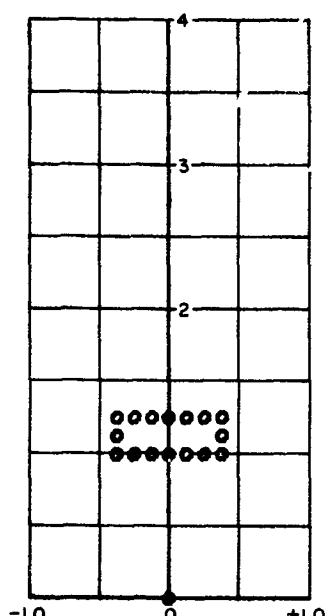
DISTANCE ~ WAVELENGTHS

2-8

DISTANCE ~ WAVELENGTHS

2-7

44

DISTANCE ~ WAVELENGTHS

2-10

DISTANCE ~ WAVELENGTHS

2-9

45
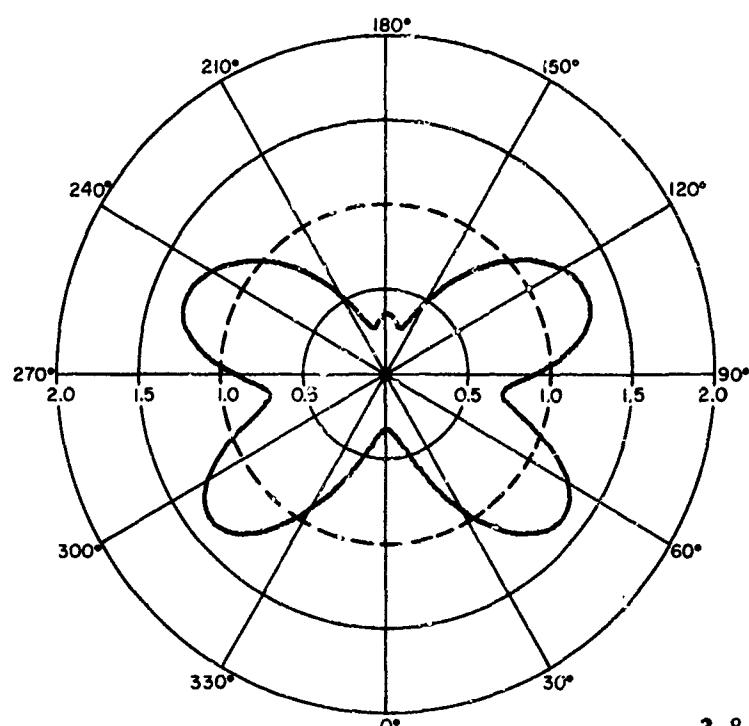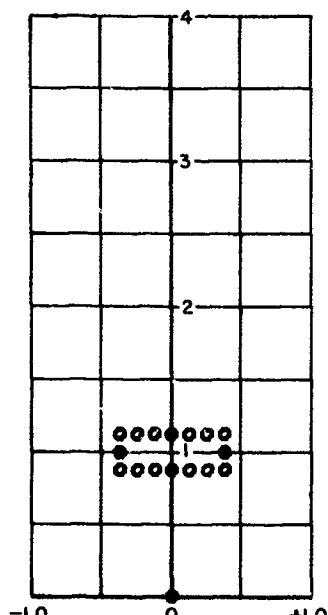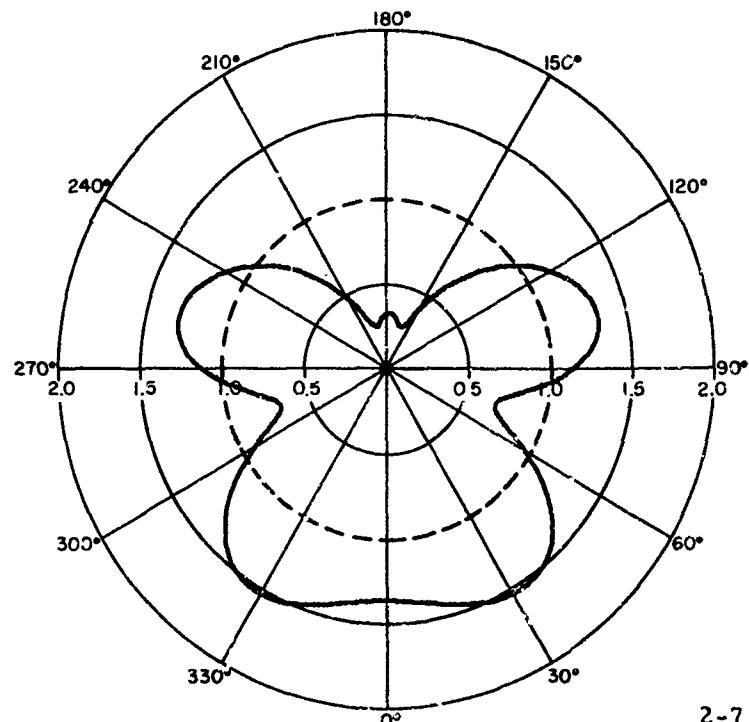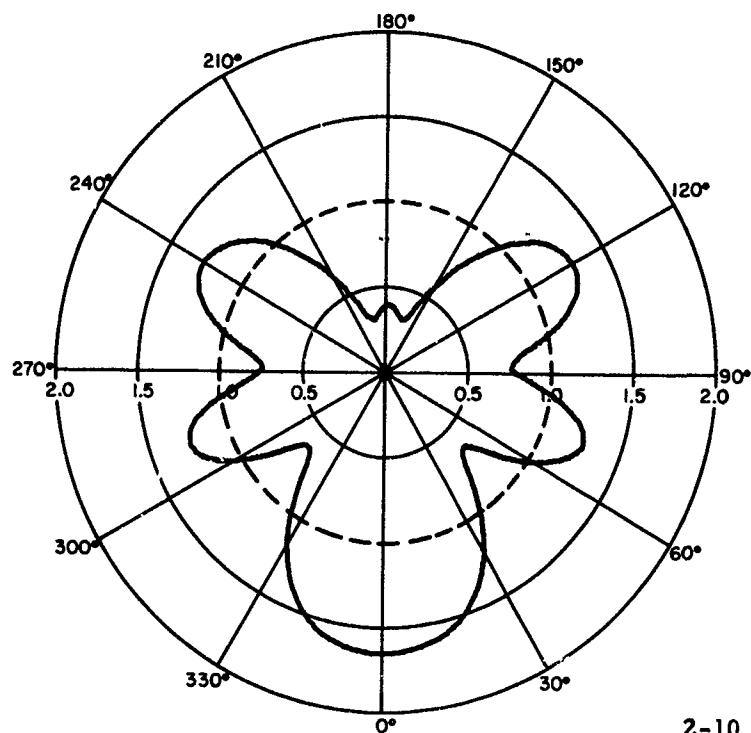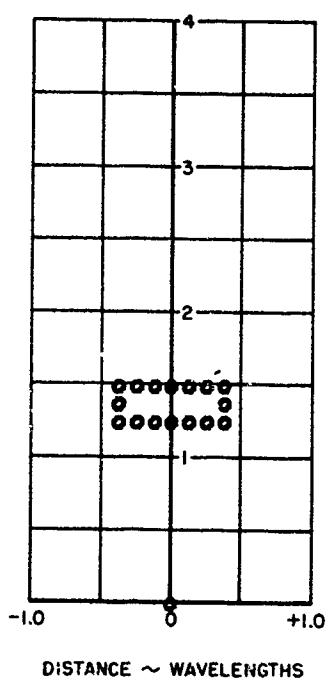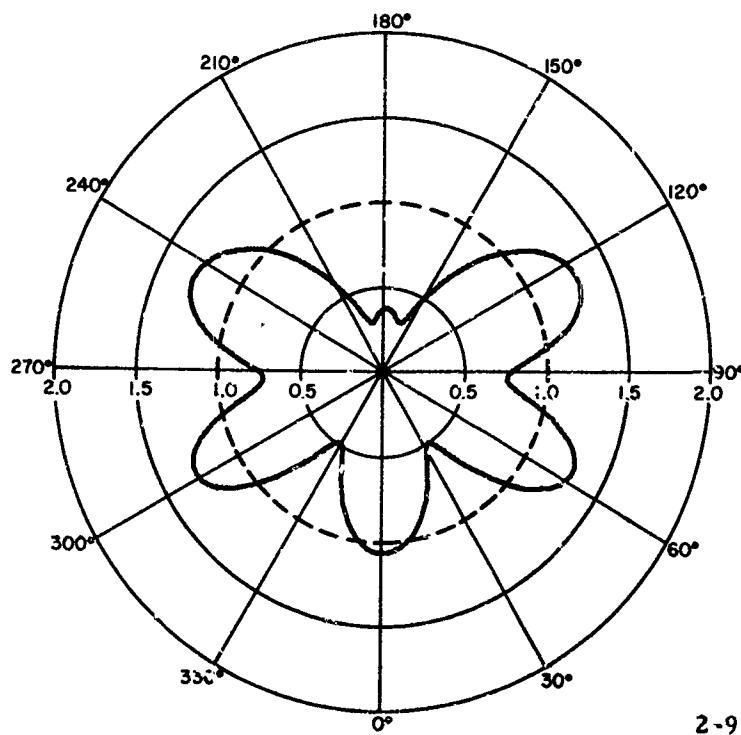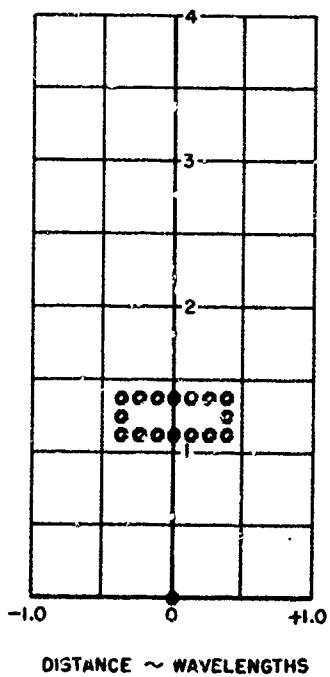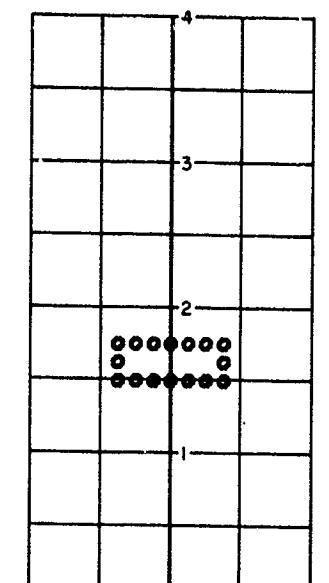
DISTANCE ~ WAVELENGTHS

2-12

DISTANCE ~ WAVELENGTHS

2-11

46

DISTANCE ~ WAVELENGTHS

2-14

DISTANCE ~ WAVELENGTHS

2-13

47

DISTANCE ~ WAVELENGTHS

2-16

DISTANCE ~ WAVELENGTHS

2-15

48

DISTANCE ~ WAVELENGTHS

2-18

DISTANCE ~ WAVELENGTHS

2-17

49
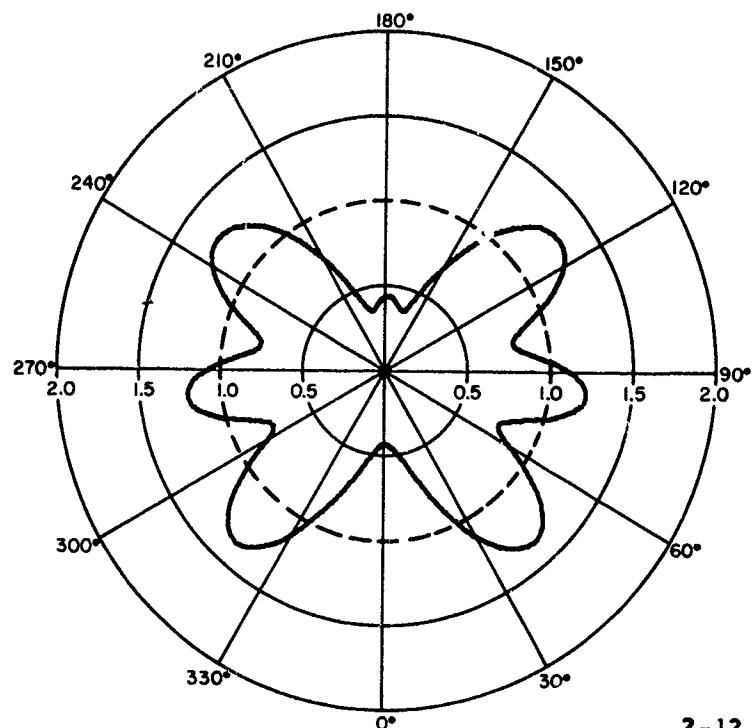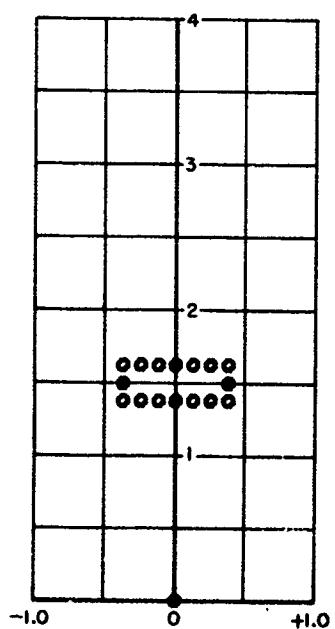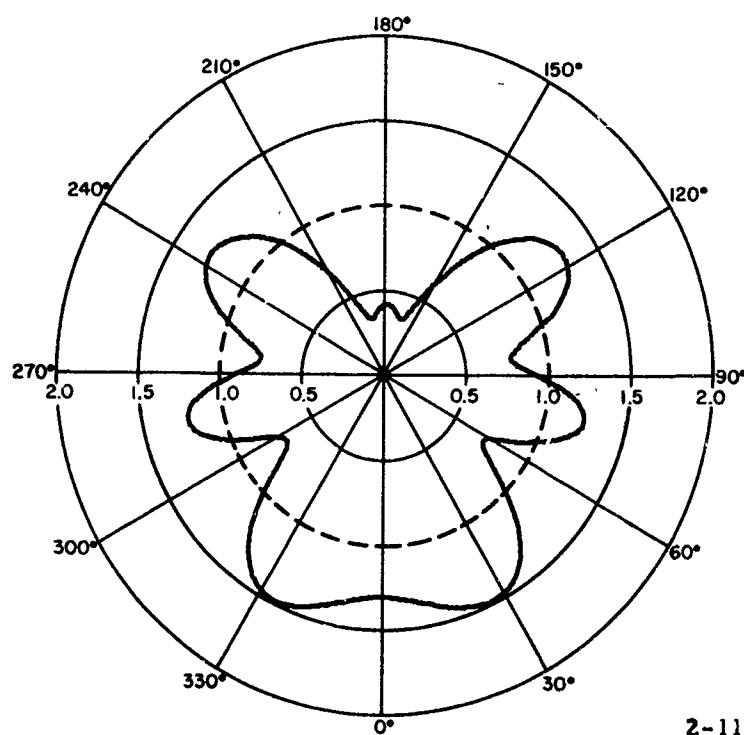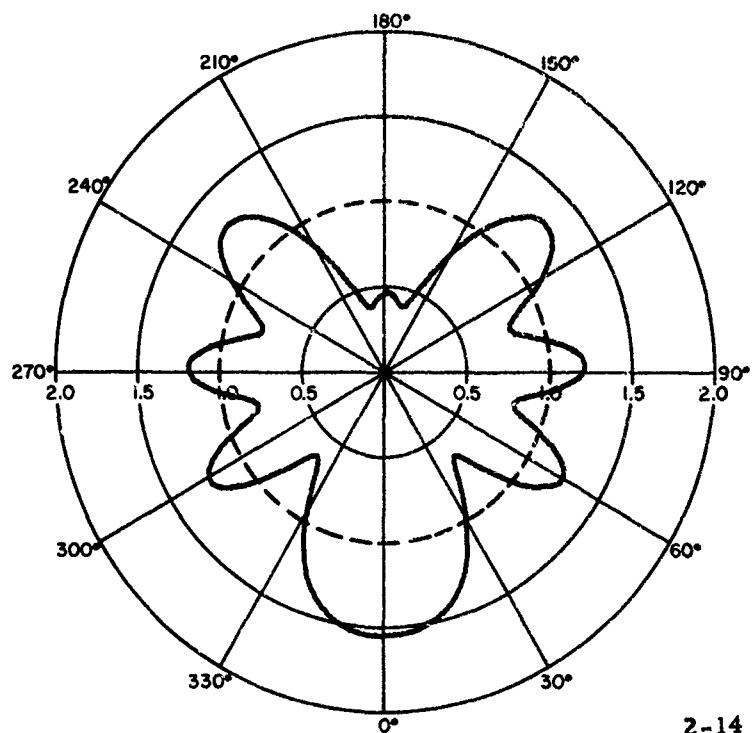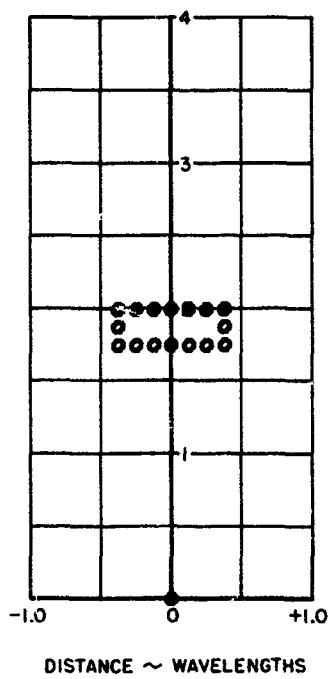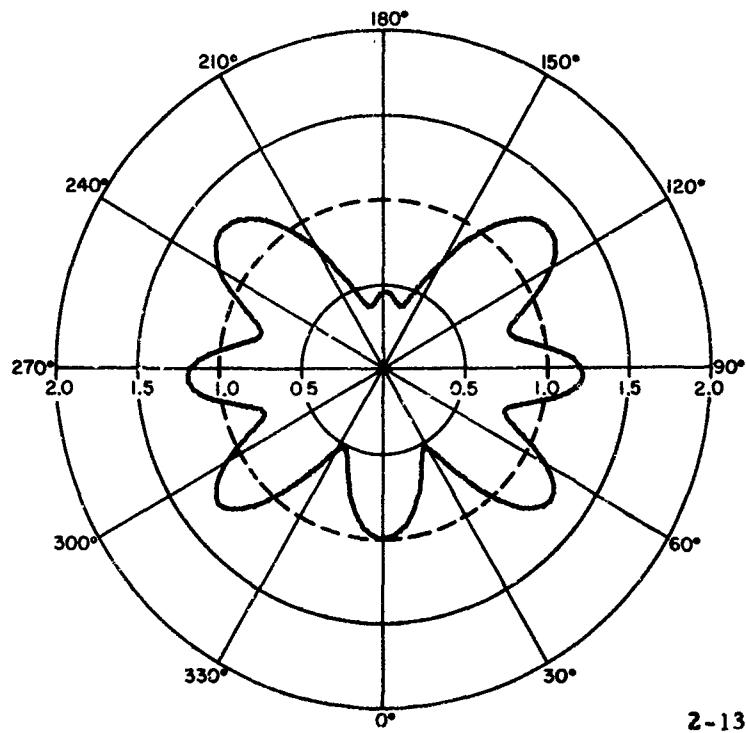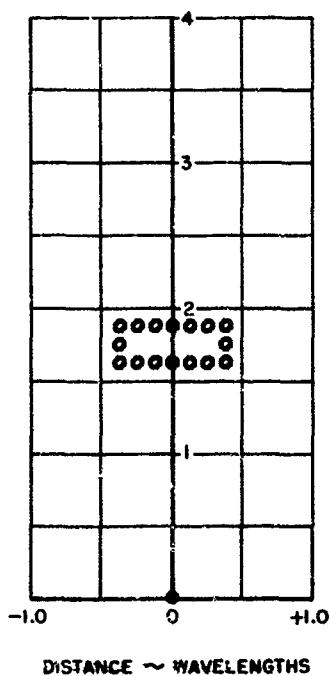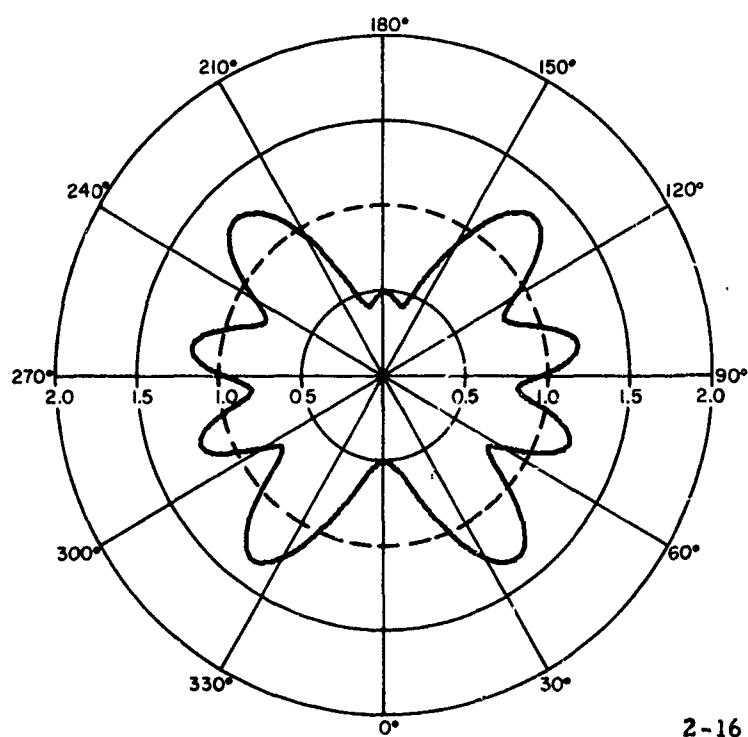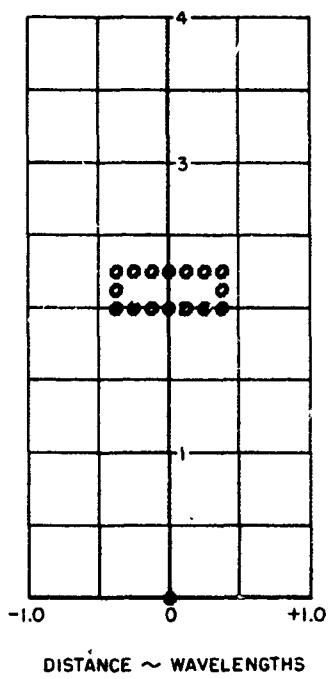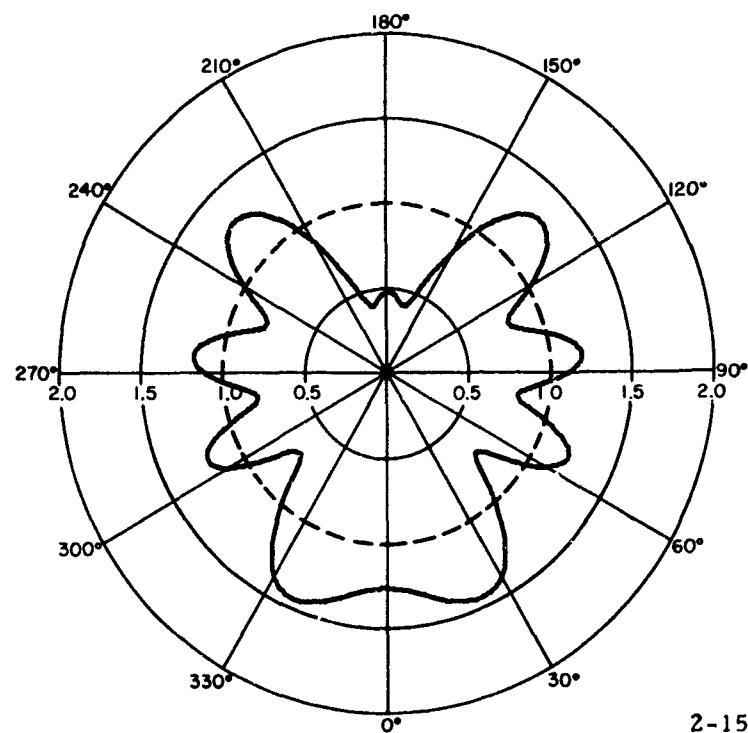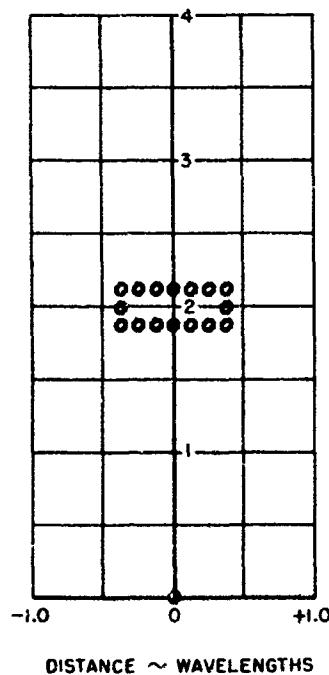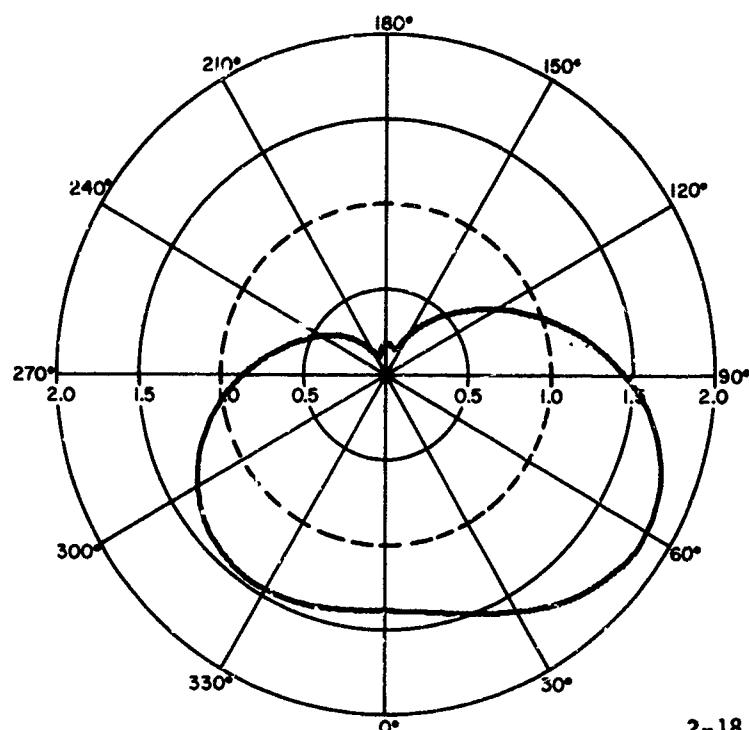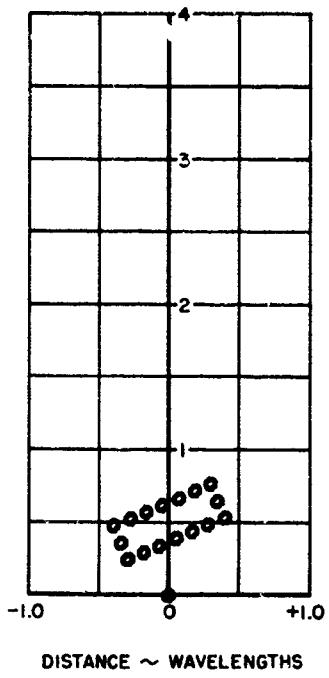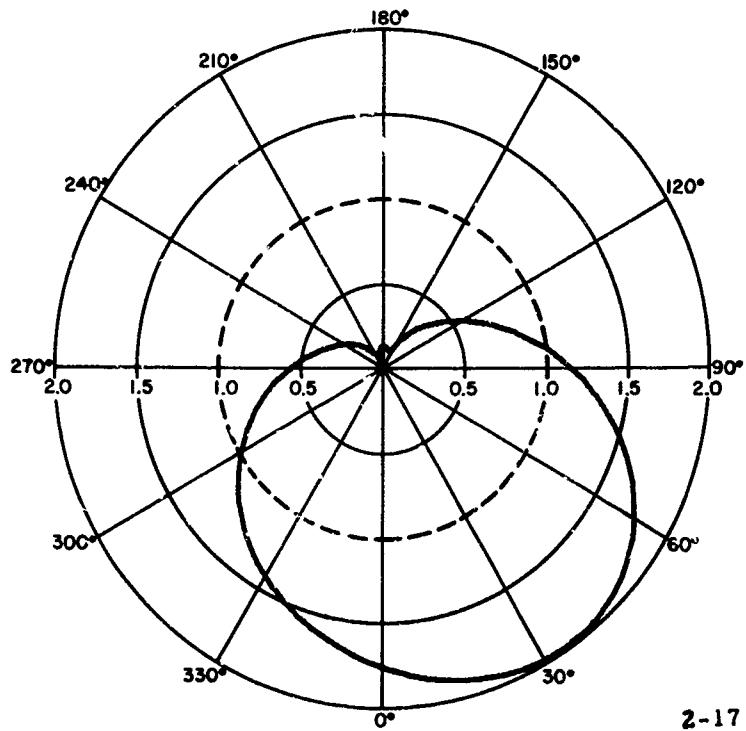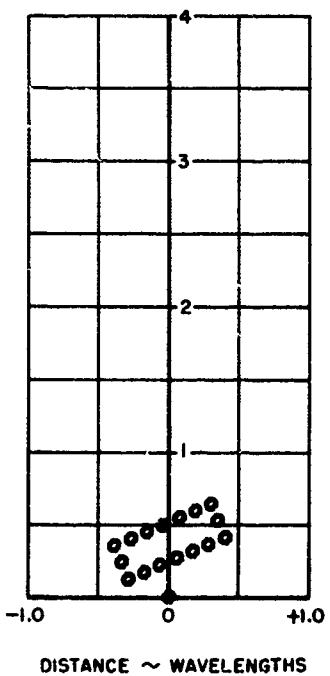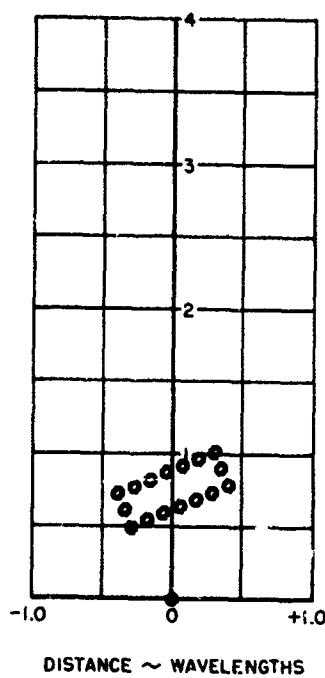
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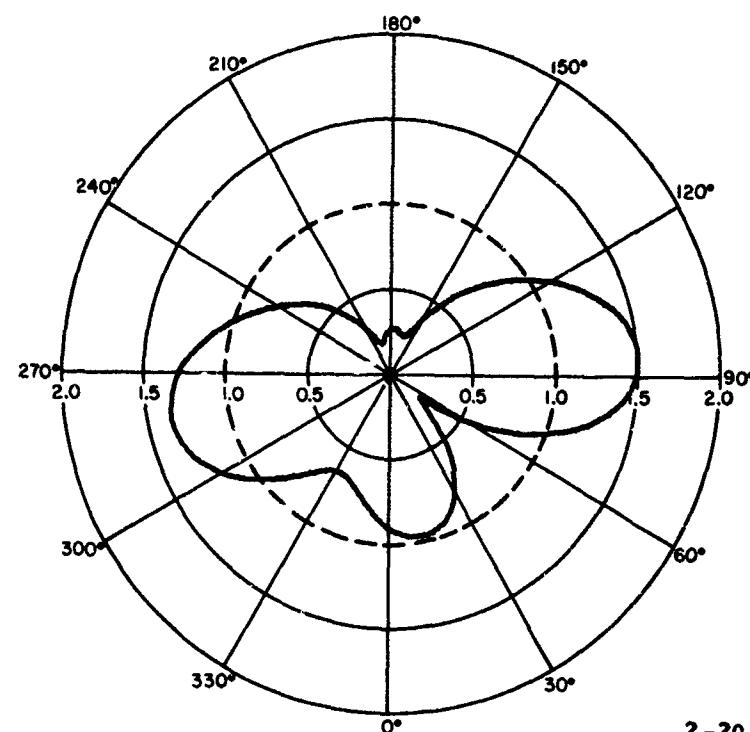
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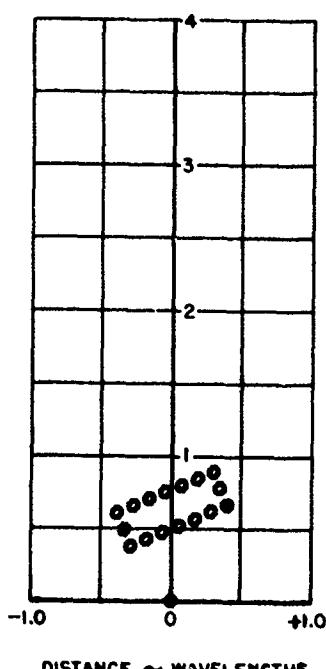
DISTANCE ～ WAVELENGTHS

2-19

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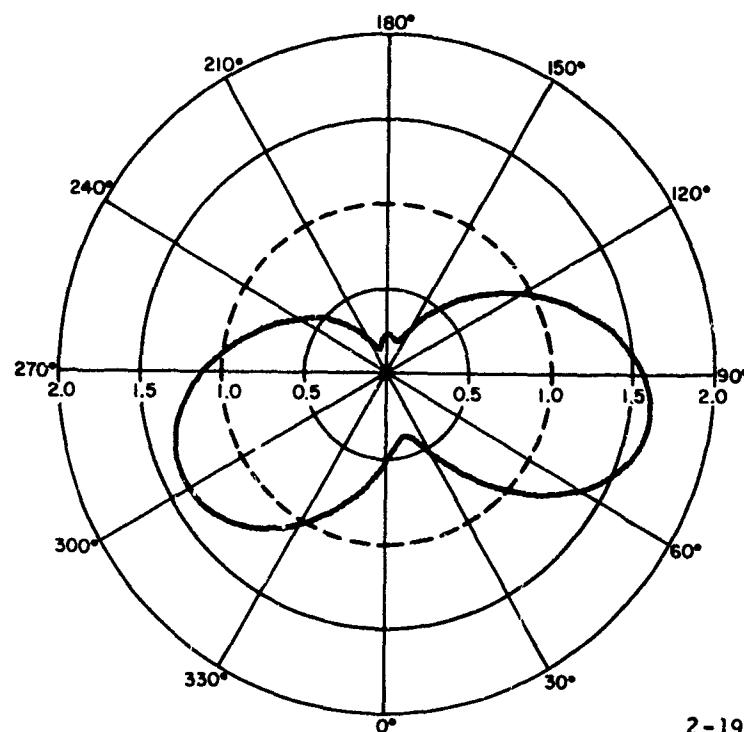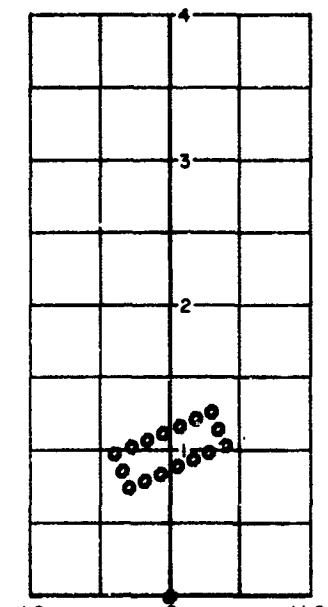
DISTANCE ~ WAVELENGTHS

2-22

DISTANCE ~ WAVELENGTHS

2-21

51

DISTANCE ~ WAVELENGTHS

2-24

DISTANCE ~ WAVELENGTHS

2-23

52

DISTANCE ~ WAVELENGTHS

2-26

DISTANCE ~ WAVELENGTHS

2-25

53

DISTANCE ~ WAVELENGTHS

2-28

DISTANCE ~ WAVELENGTHS

2-27

54
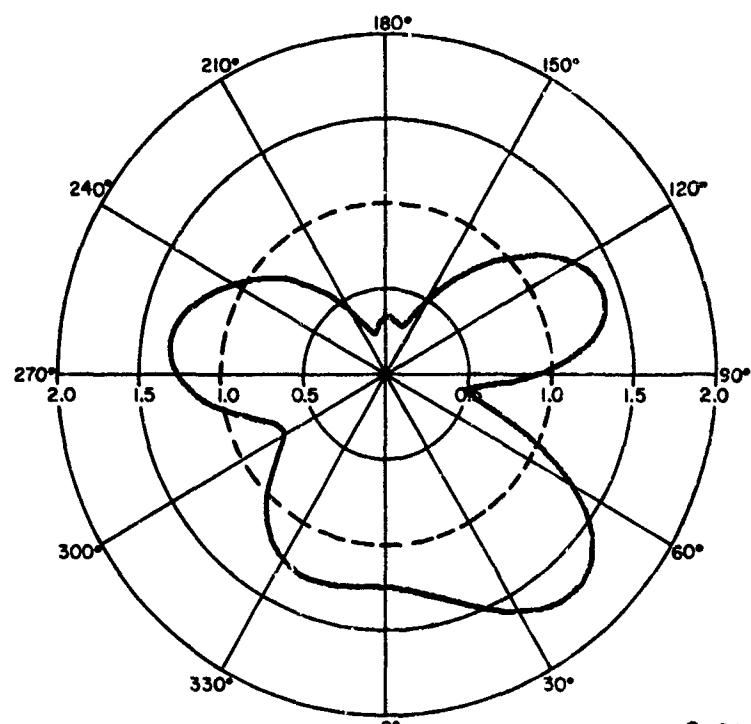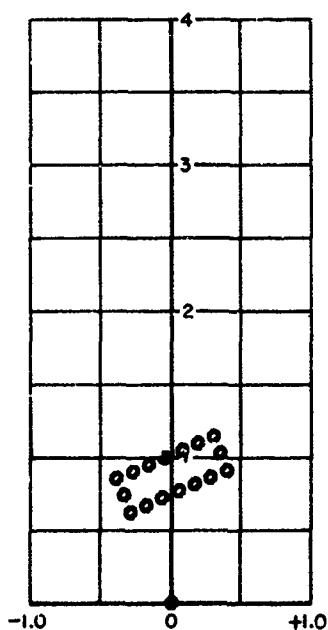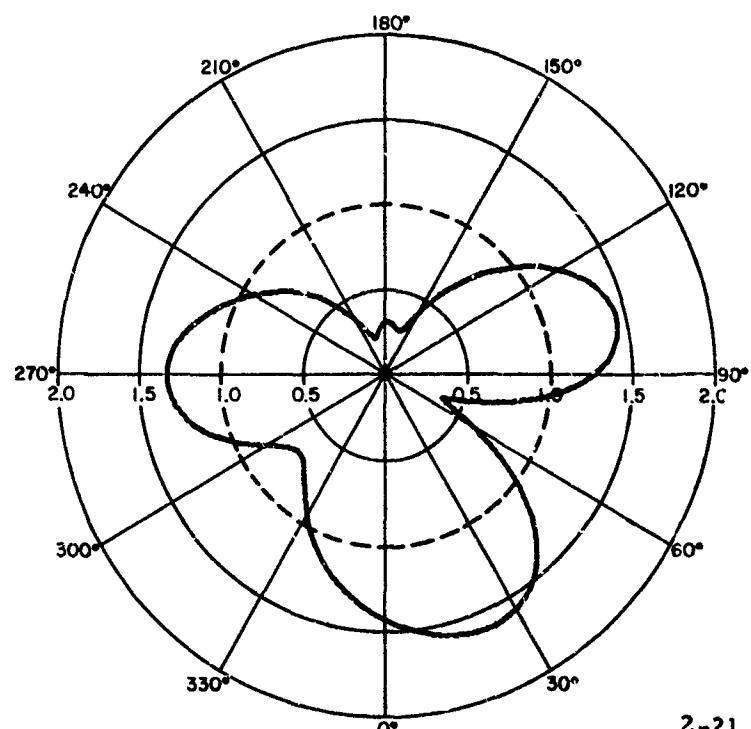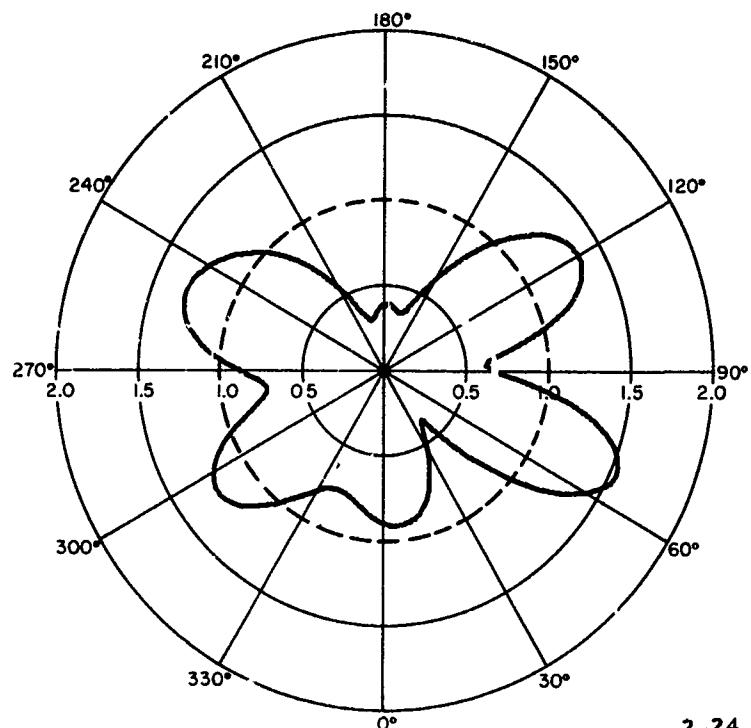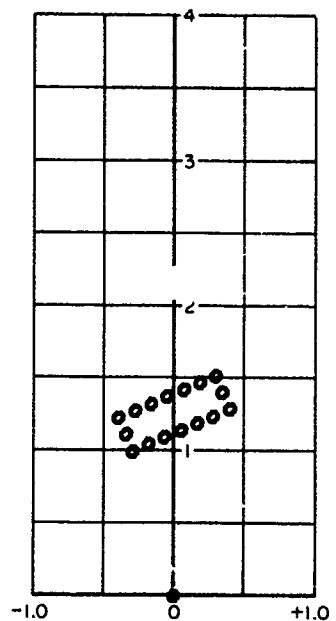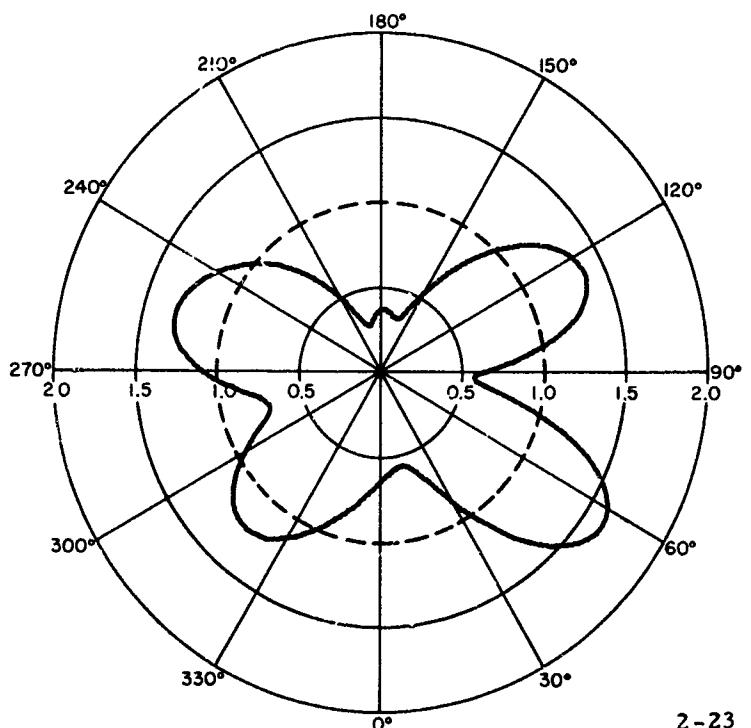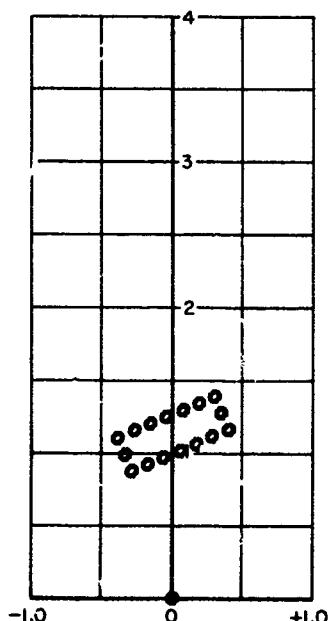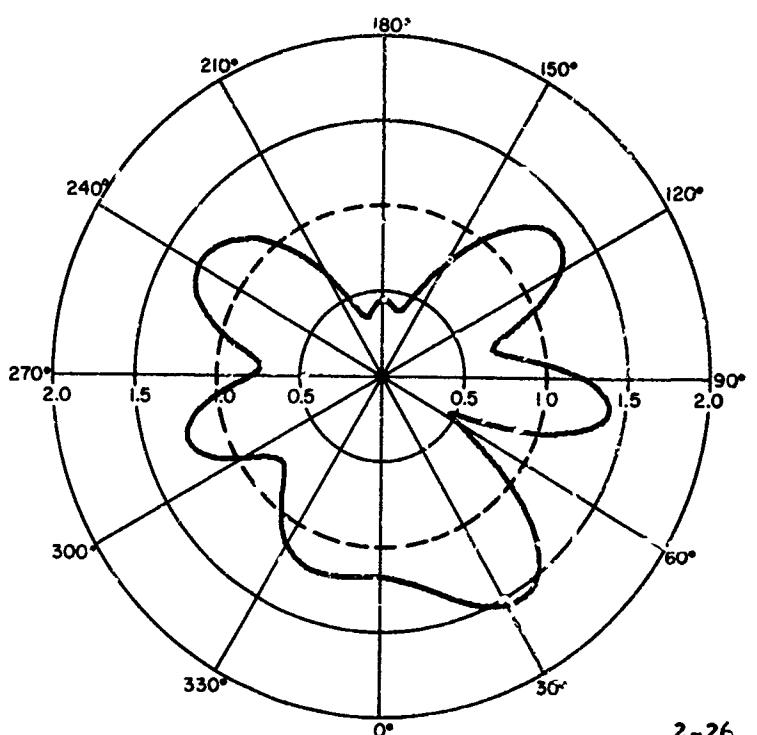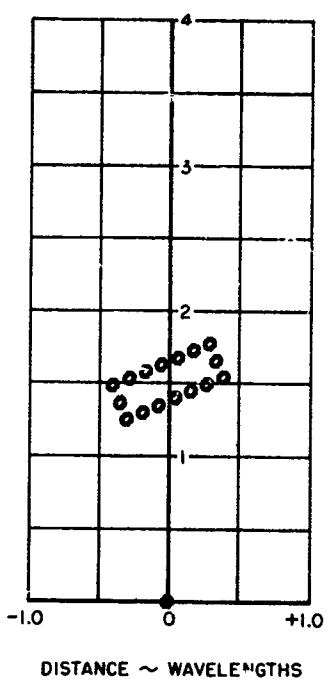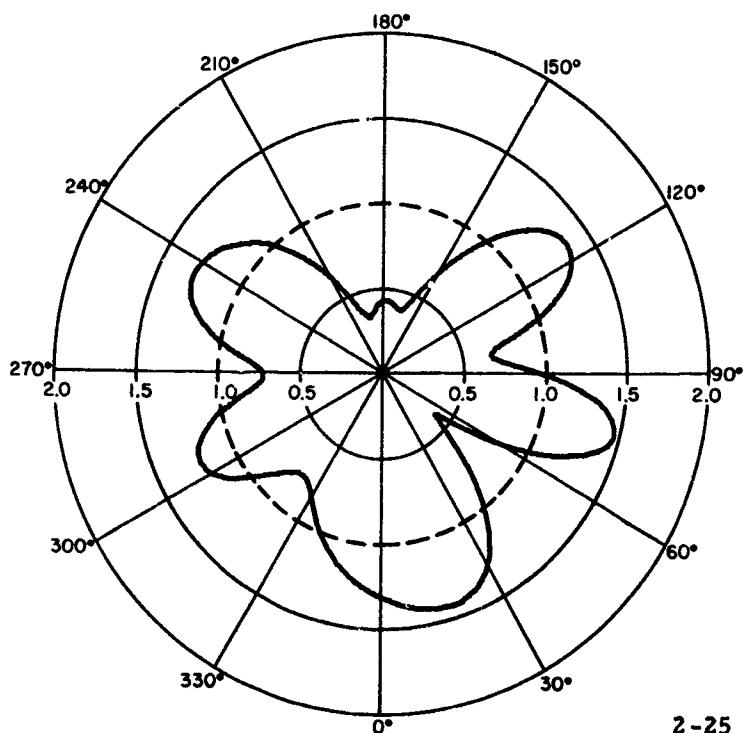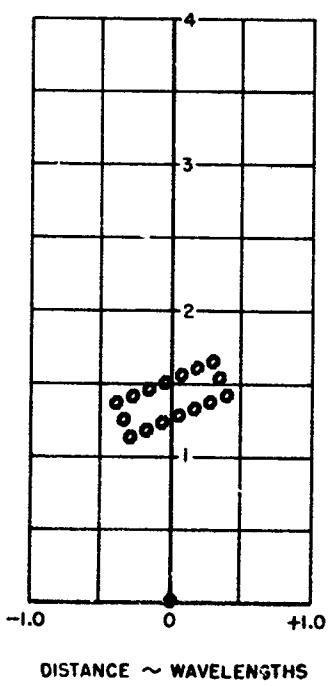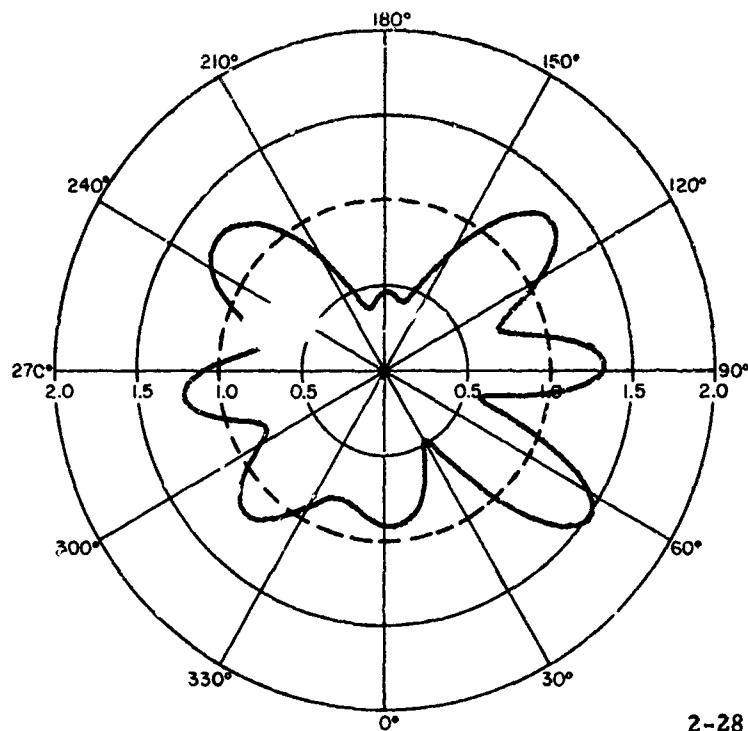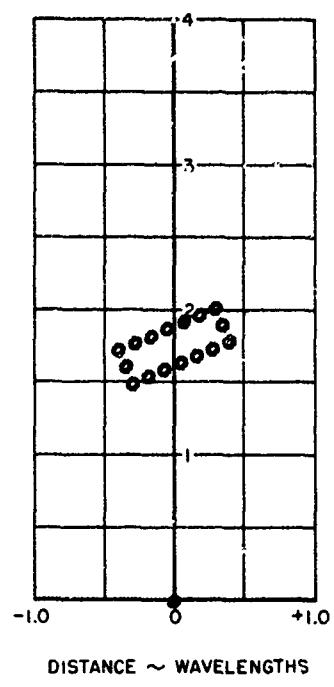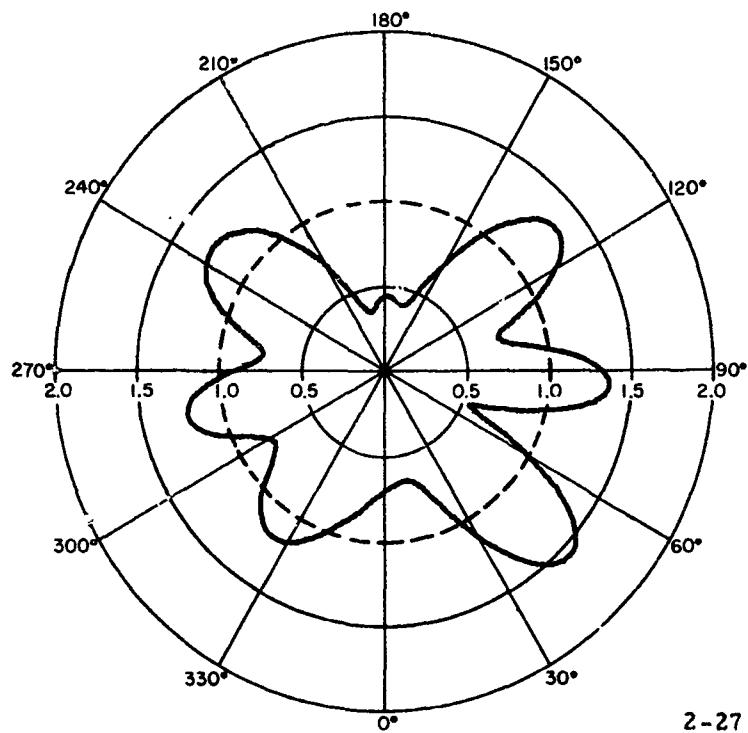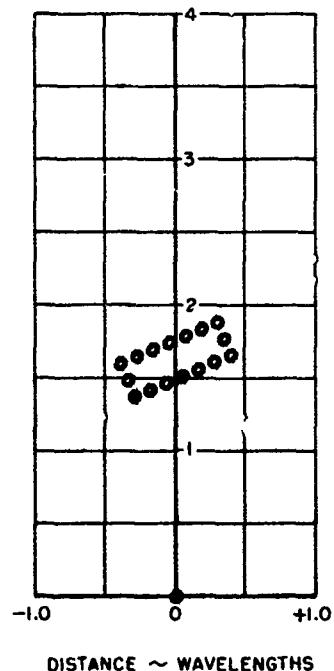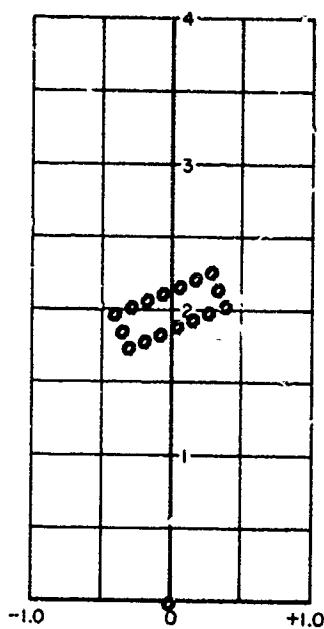
DISTANCE ~ WAVELENGTHS

2-30

DISTANCE ~ WAVELENGTHS

2-29

55

DISTANCE ~ WAVELENGTHS

2-32

DISTANCE ~ WAVELENGTHS

2-31

56
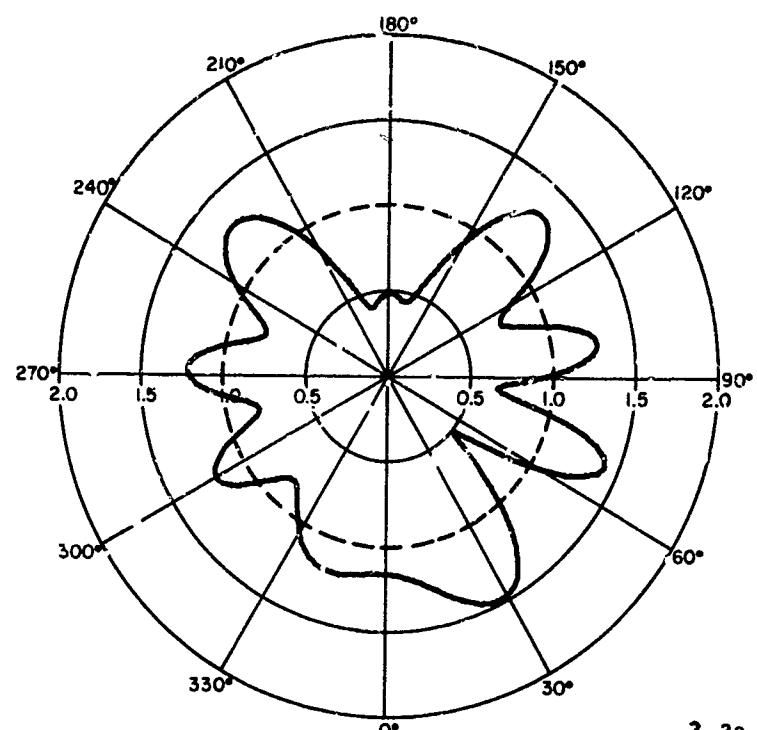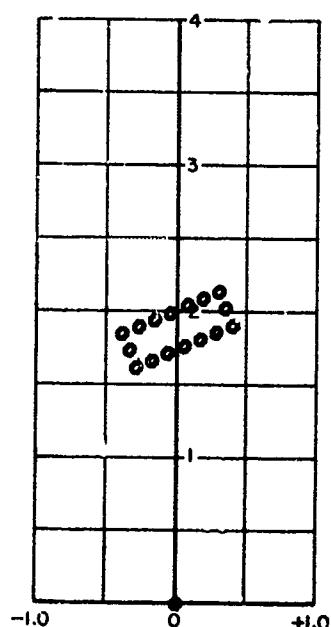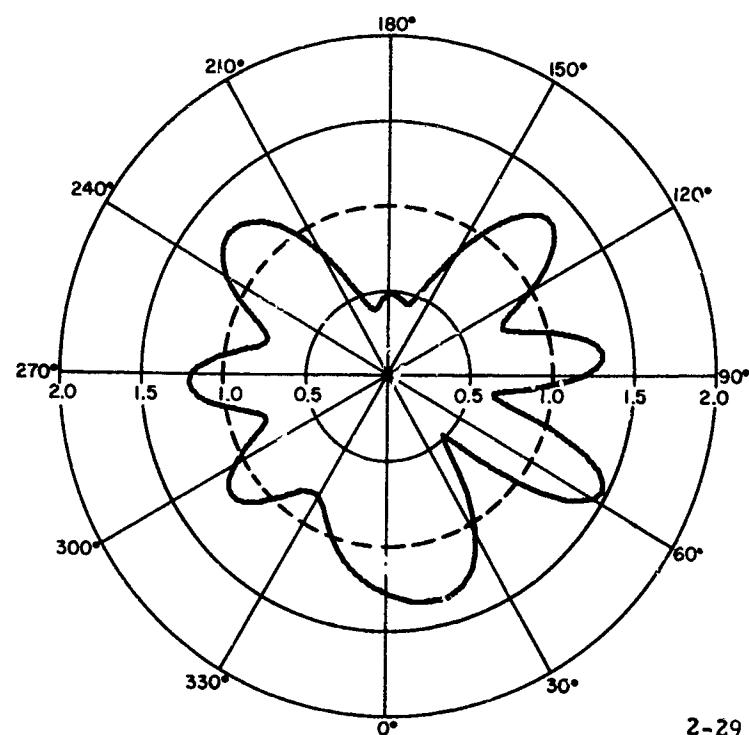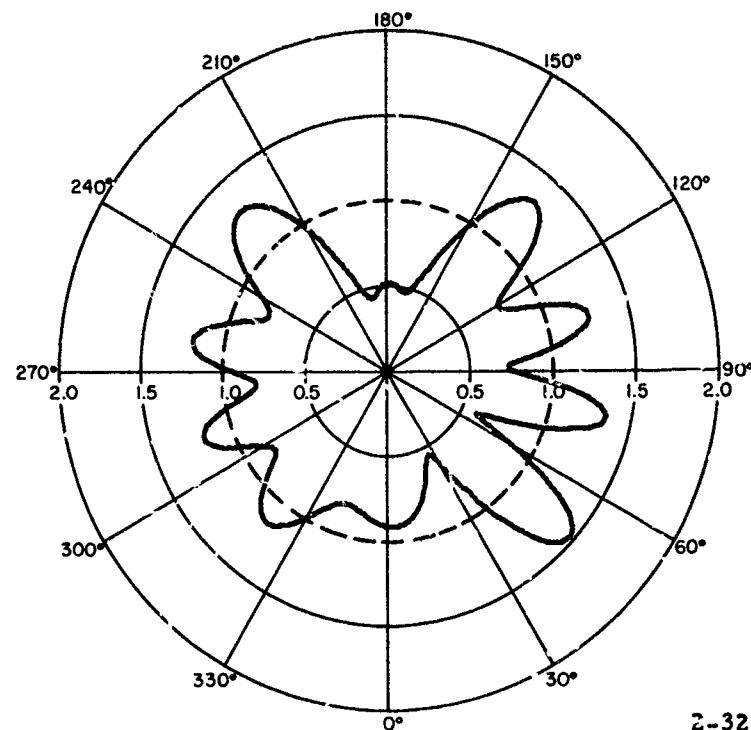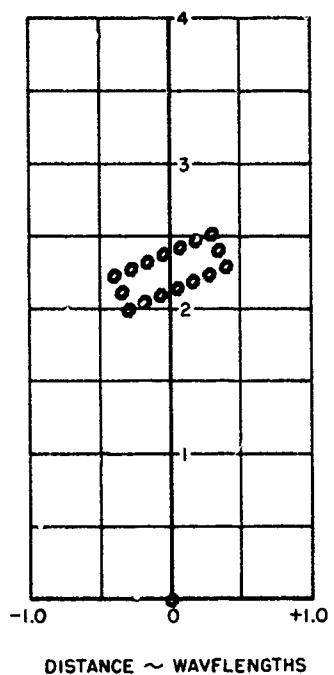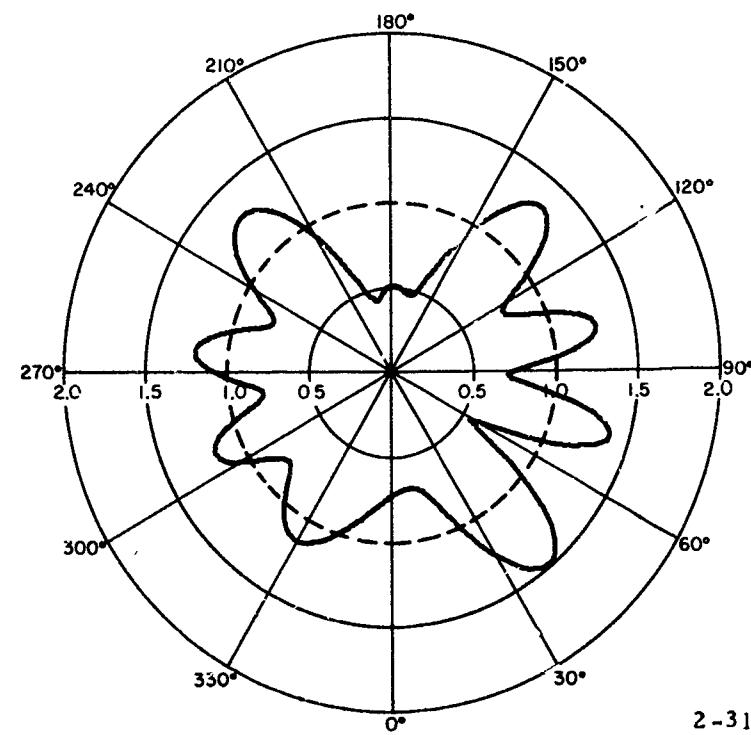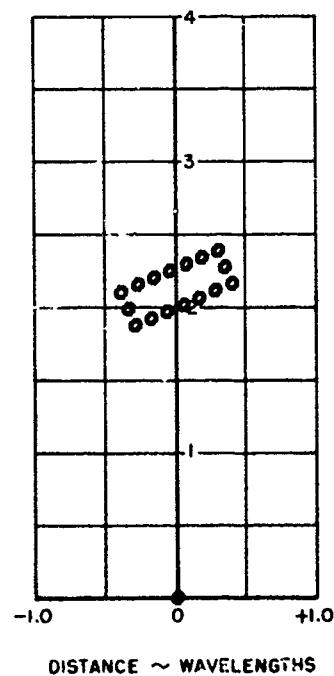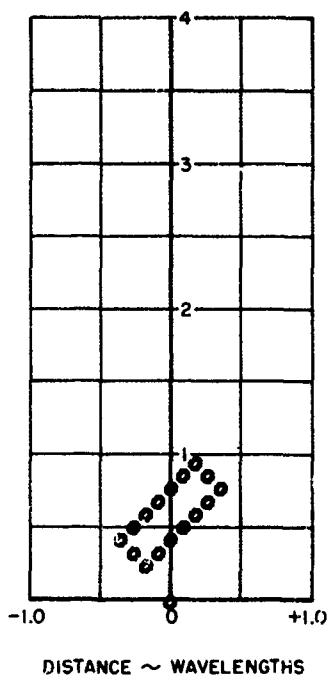
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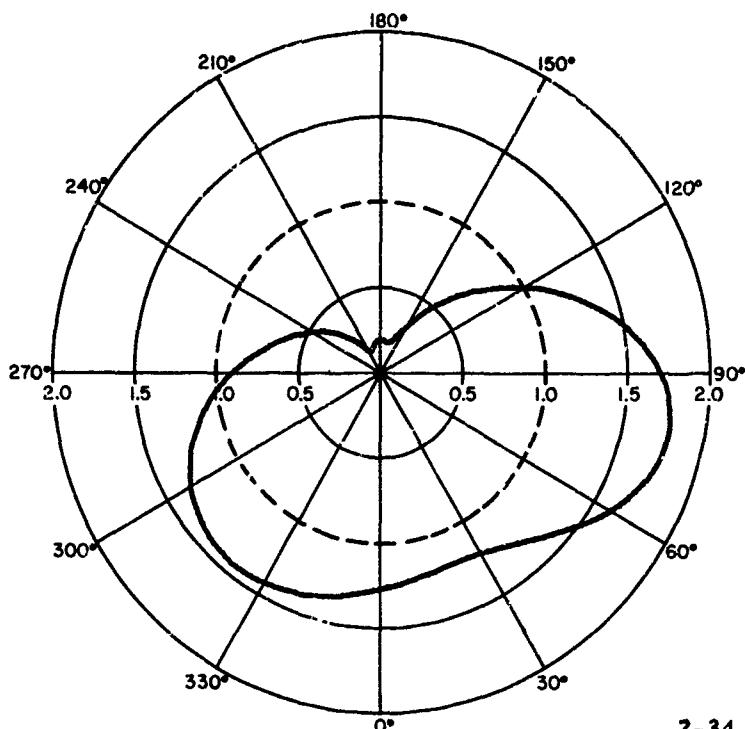
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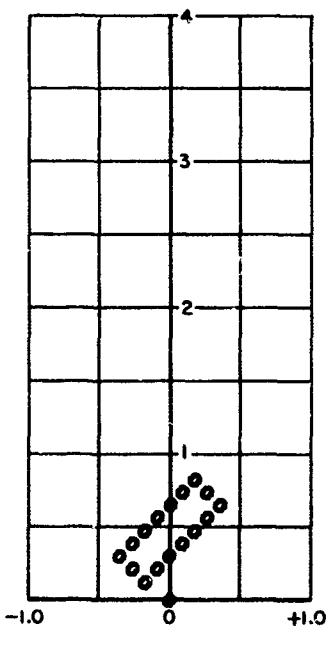
DISTANCE ~ WAVELENGTHS

2-33

57
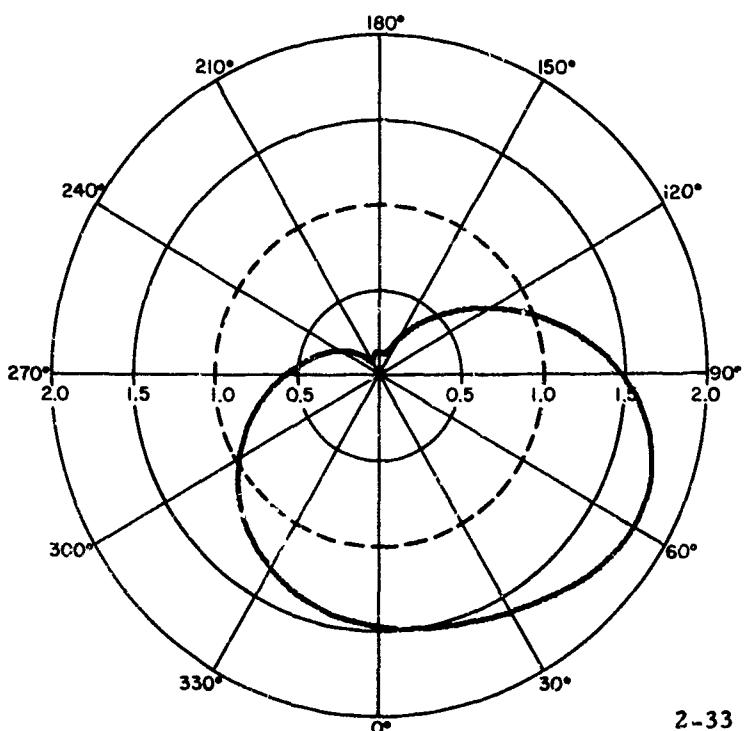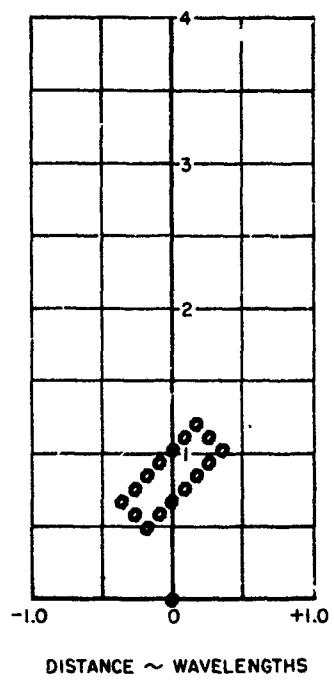
DISTANCE ~ WAVELENGTHS
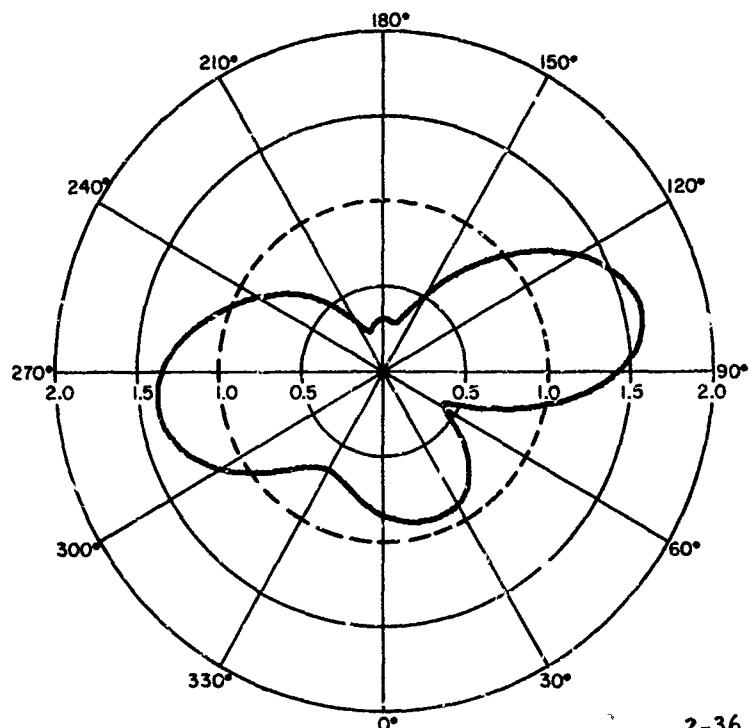
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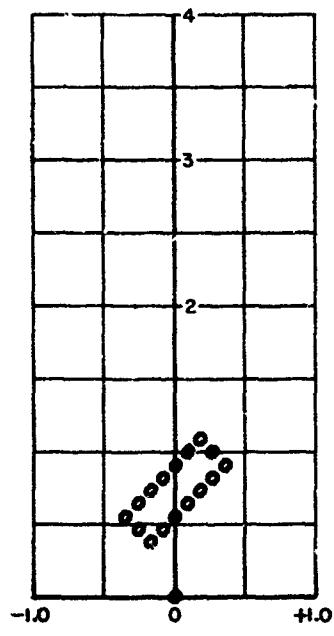
DISTANCE ~ WAVELENGTHS

2-35

58
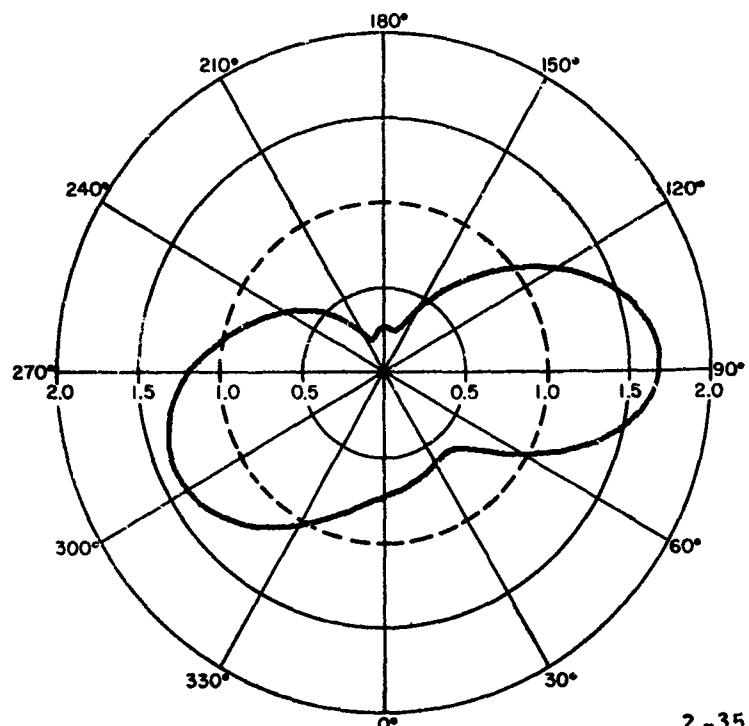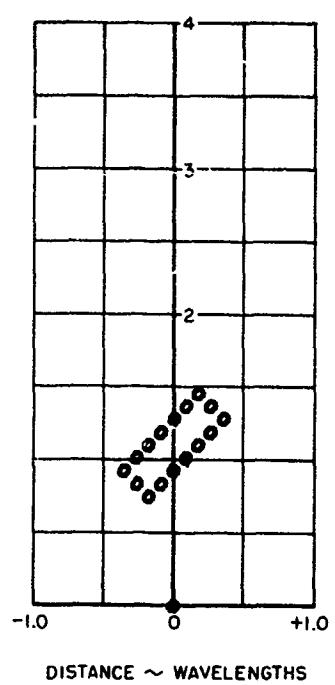
DISTANCE ~ WAVELENGTHS
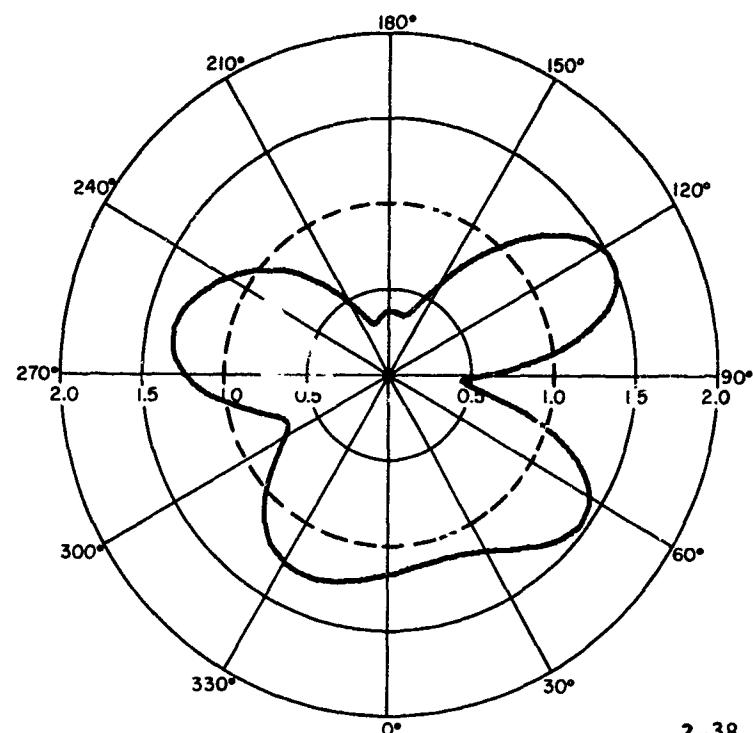
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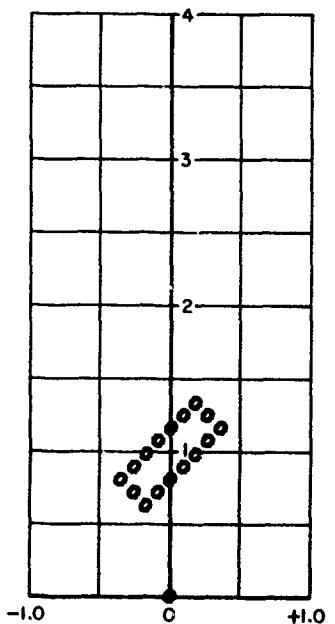

DISTANCE ~ WAVELENGTHS

2-37

59
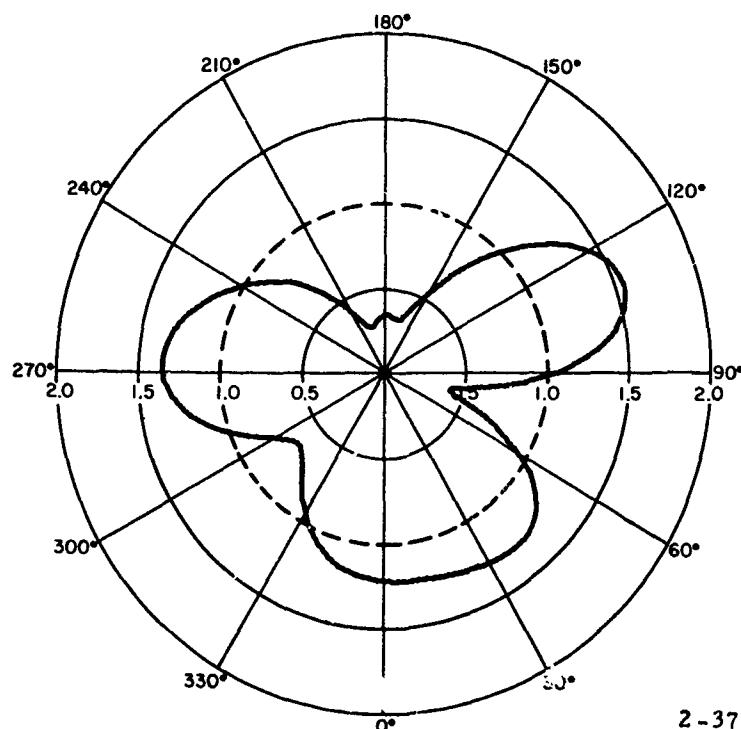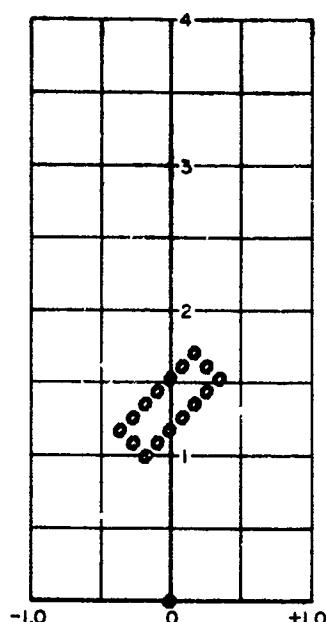
DISTANCE ~ WAVELENGTHS

2-40

DISTANCE ~ WAVELENGTHS

2-39

60

DISTANCE ~ WAVELENGTHS

2-42

DISTANCE ~ WAVELENGTHS

2-41

61
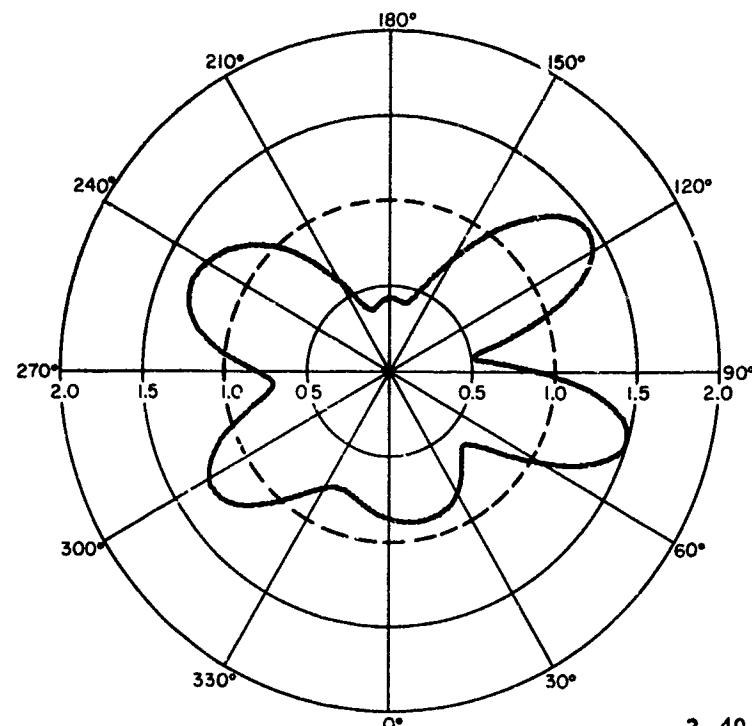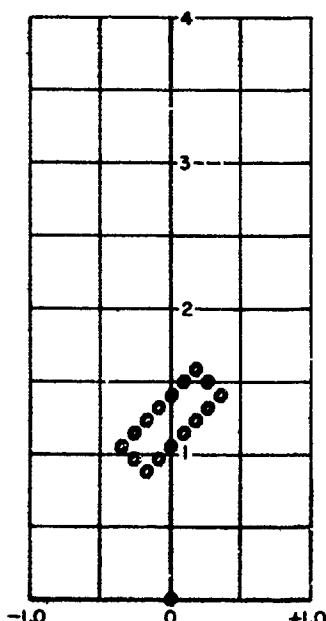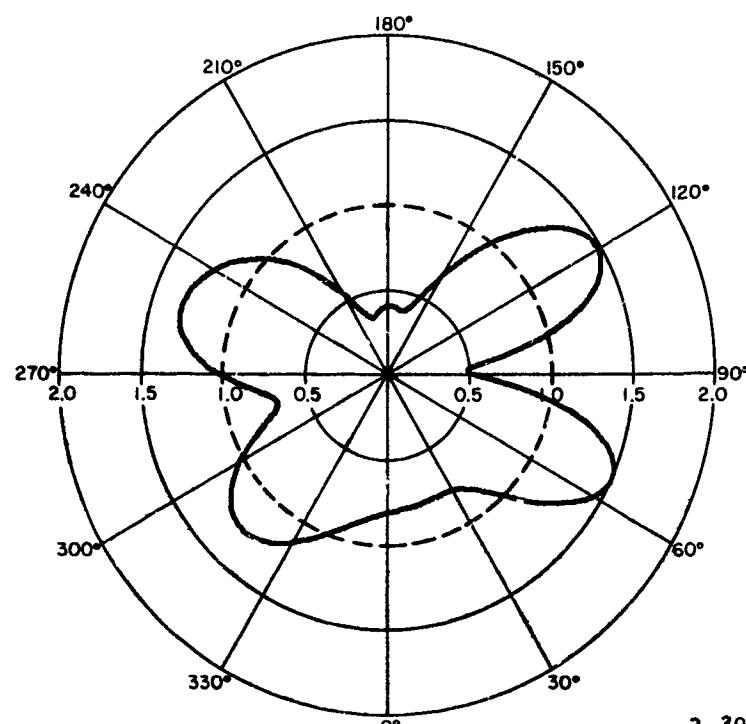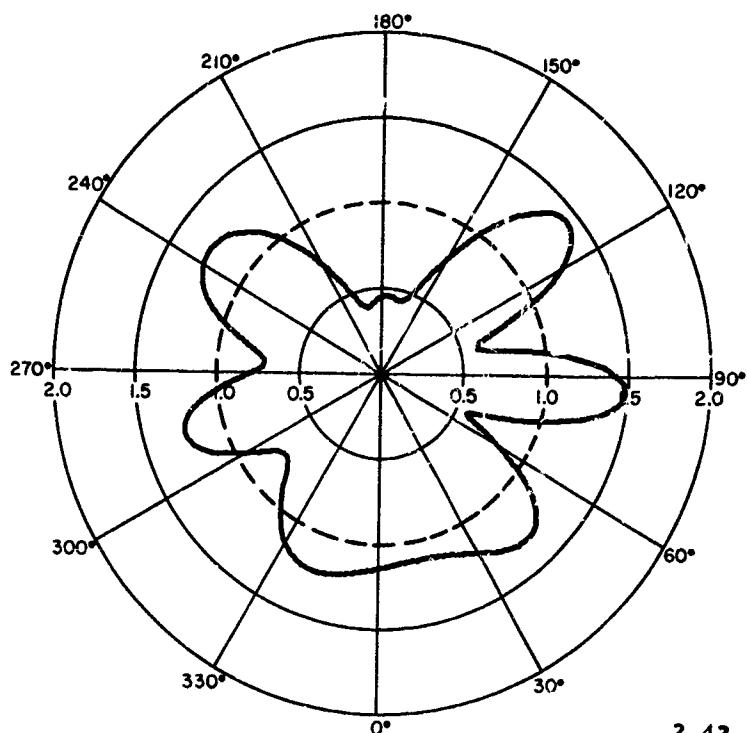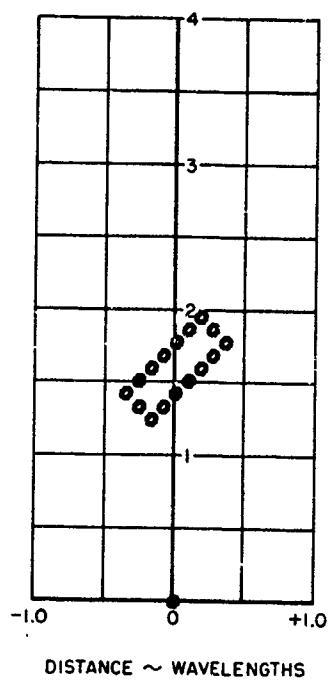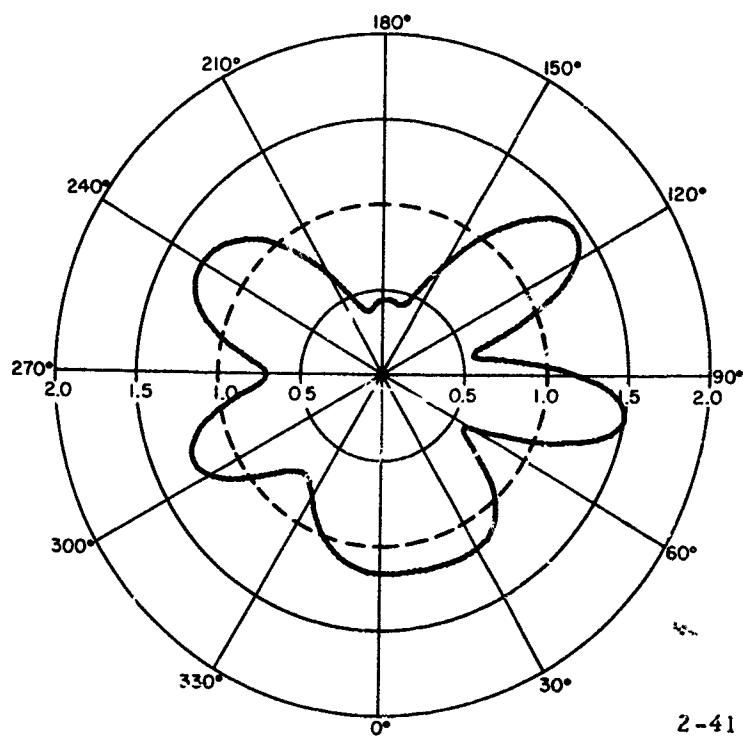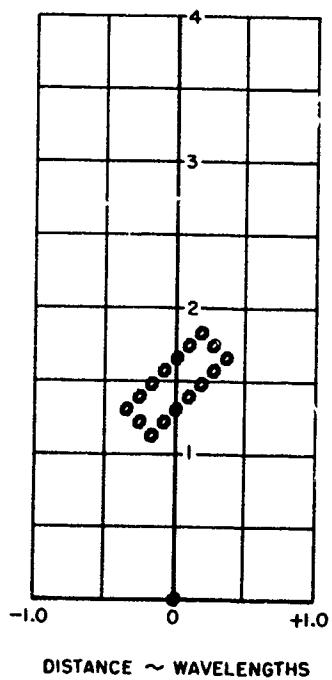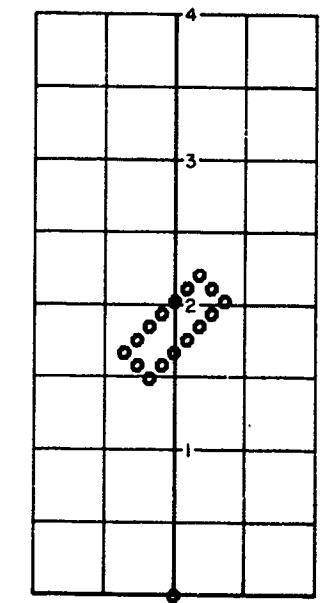
DISTANCE ~ WAVELENGTHS

2-44

DISTANCE ~ WAVELENGTHS

2-43

62

DISTANCE ~ WAVELENGTHS

2-46

DISTANCE ~ WAVELENGTHS

2-45

63

DISTANCE ~ WAVELENGTHS

2-48

DISTANCE ~ WAVELENGTHS

2-47

64

DISTANCE ~ WAVELENGTHS

2-50

DISTANCE ~ WAVELENGTHS

2-49

65

DISTANCE ~ WAVELENGTHS

2-52

DISTANCE ~ WAVELENGTHS

2-51

66
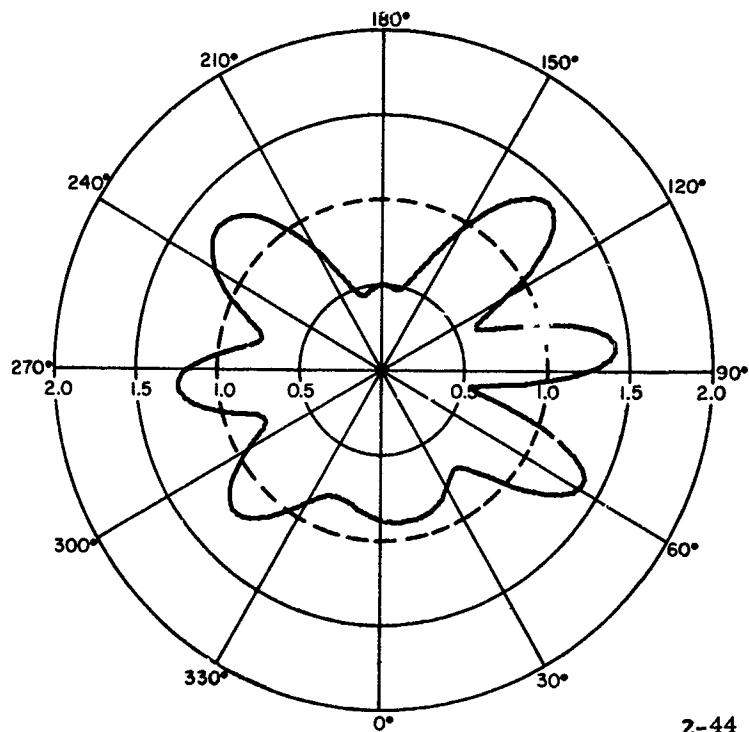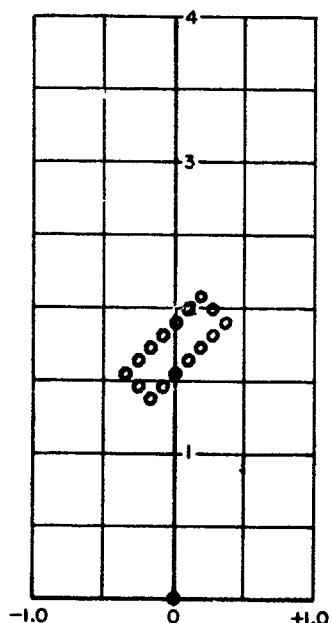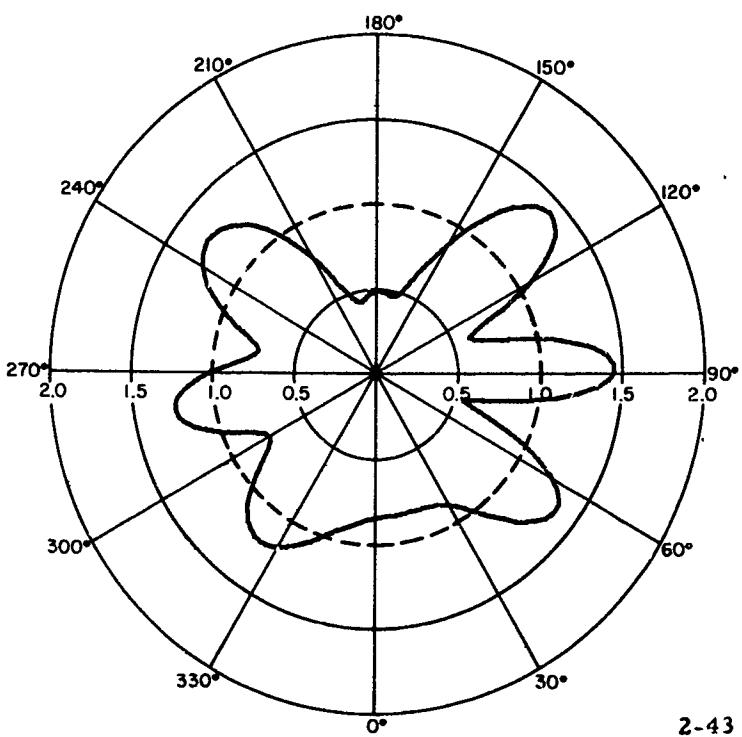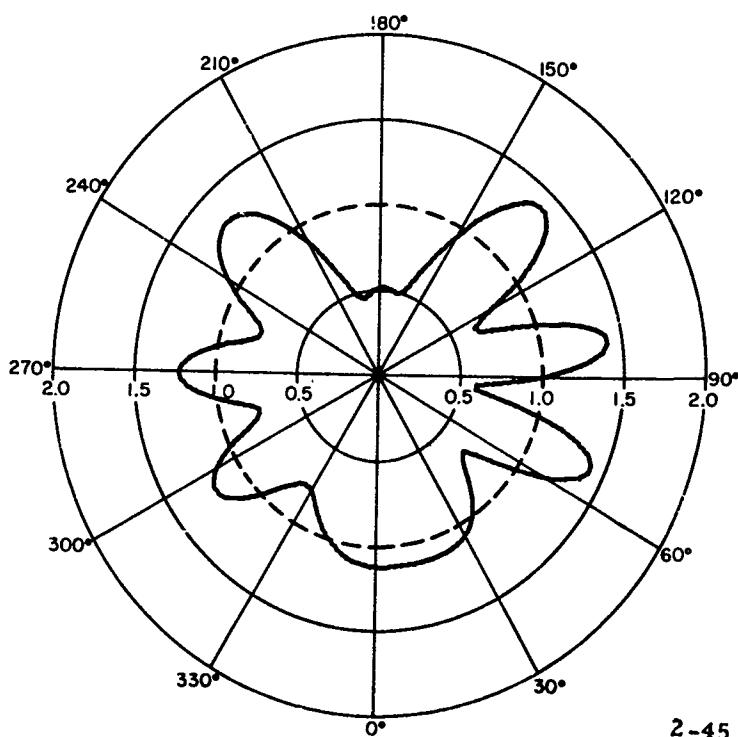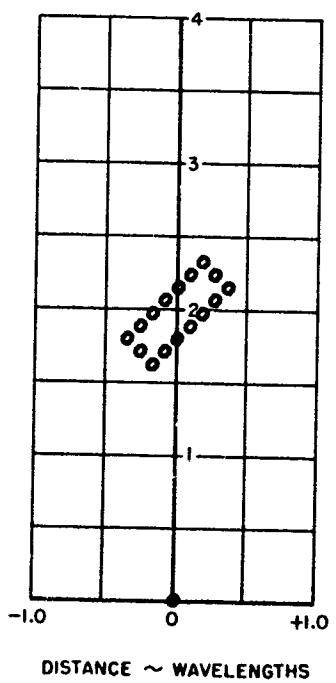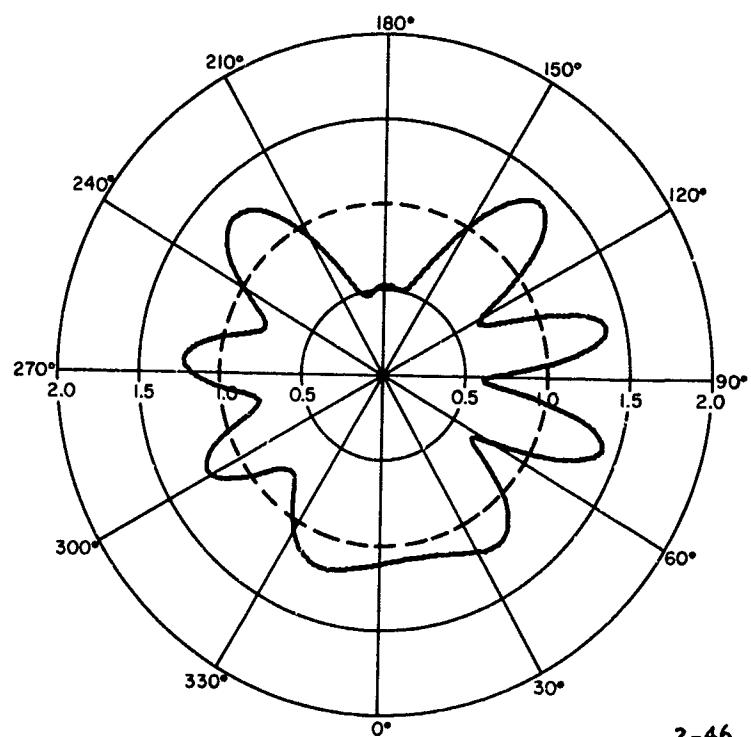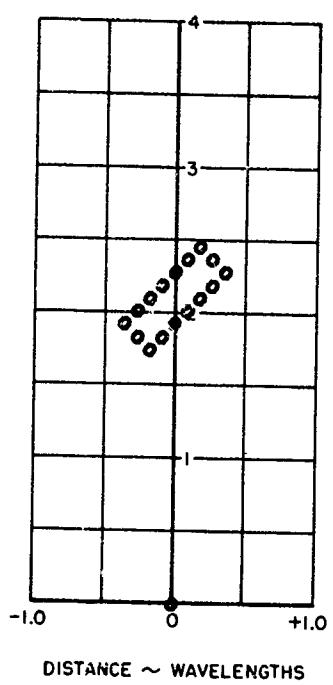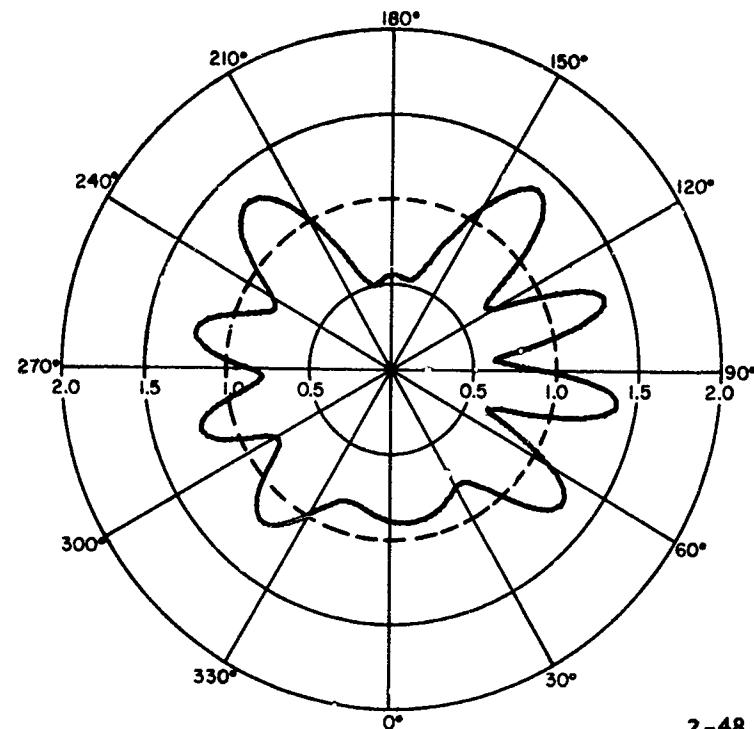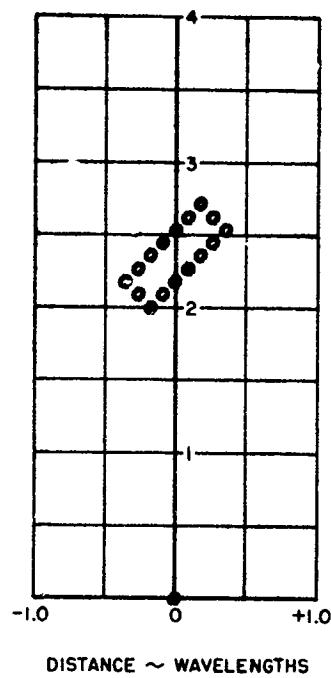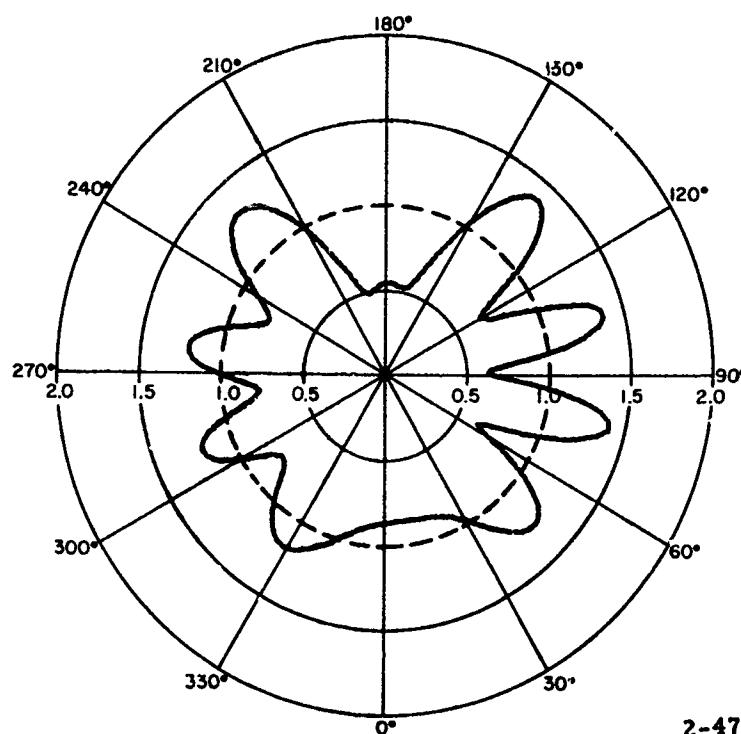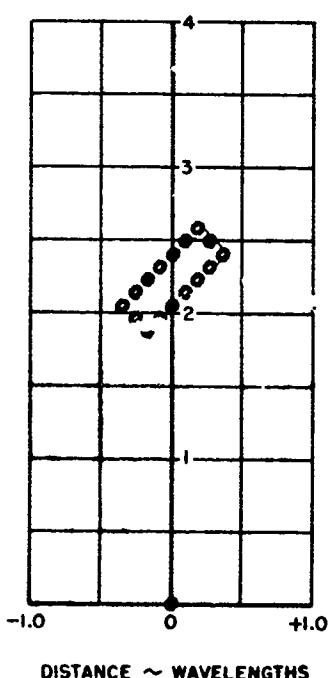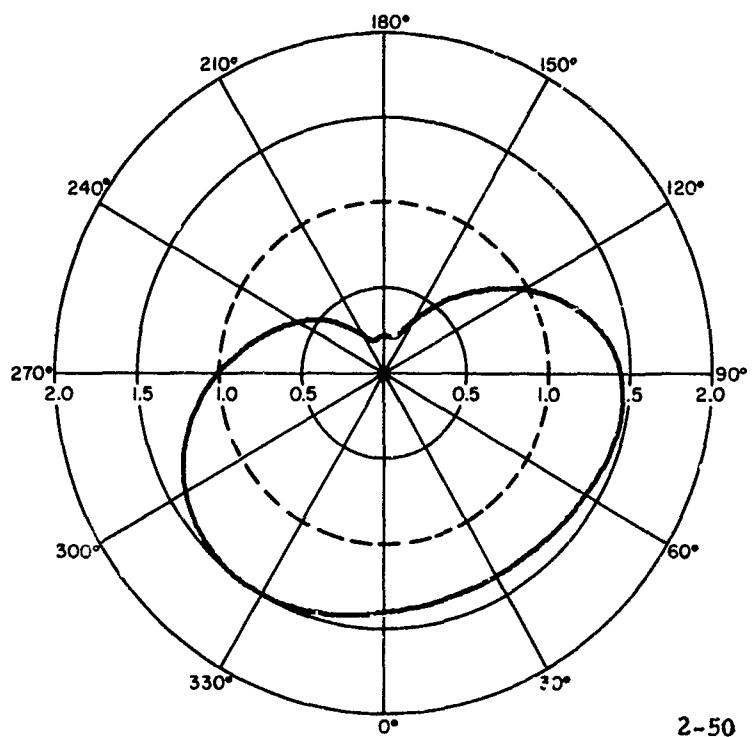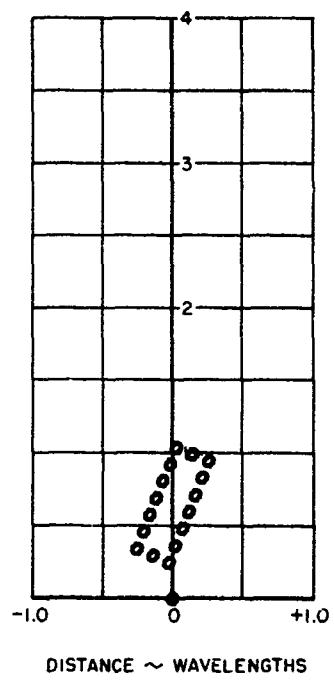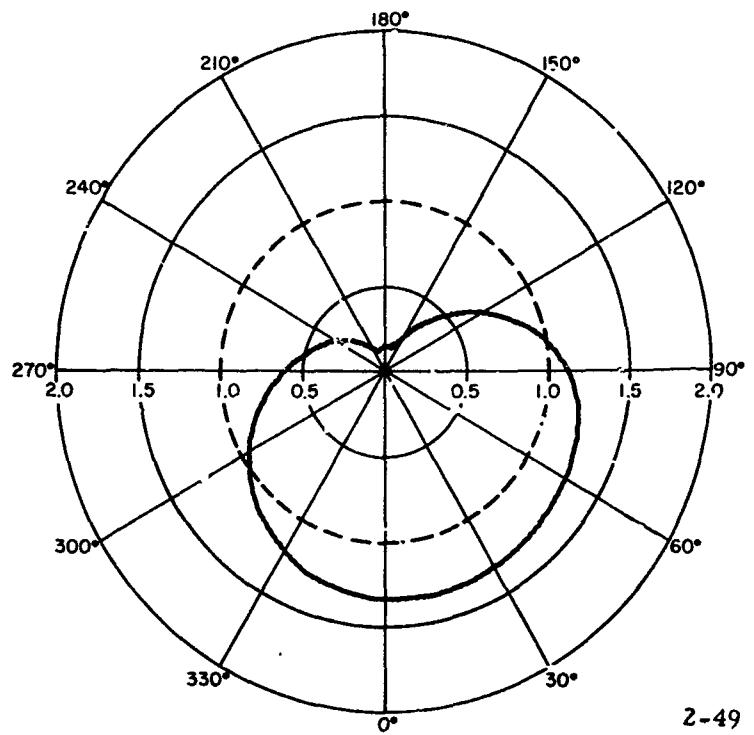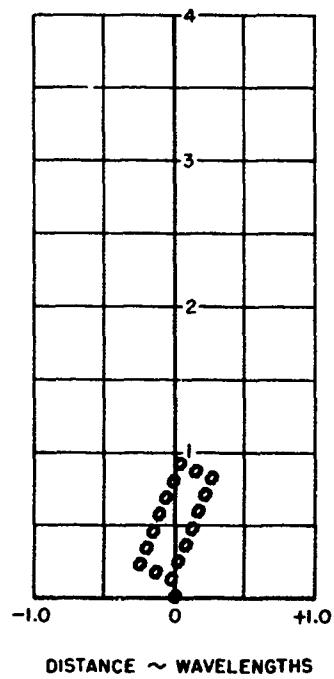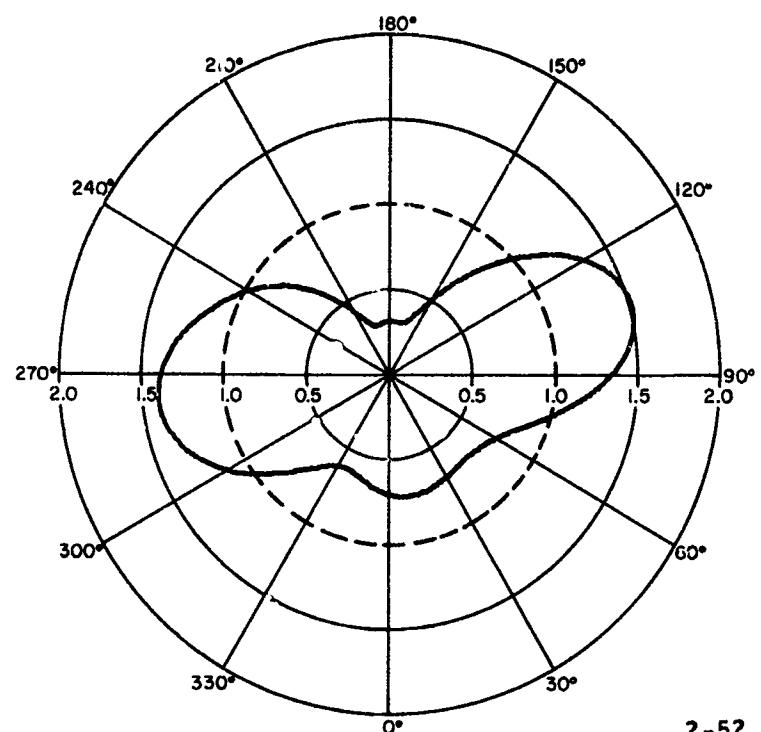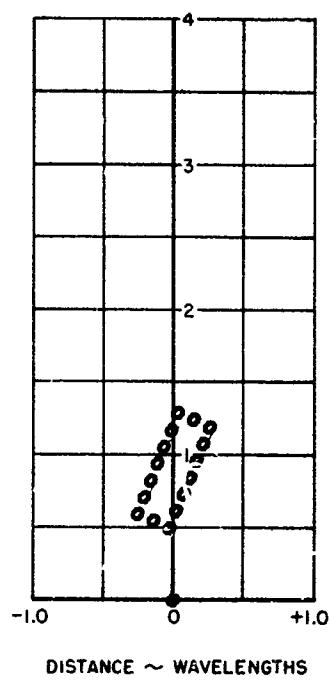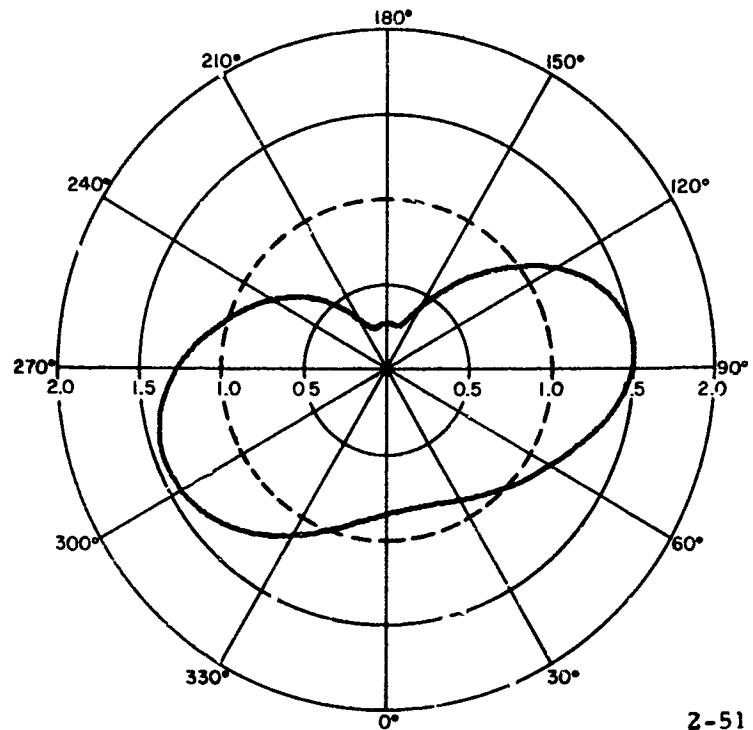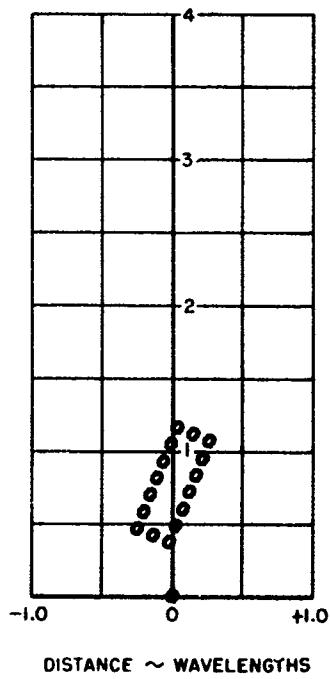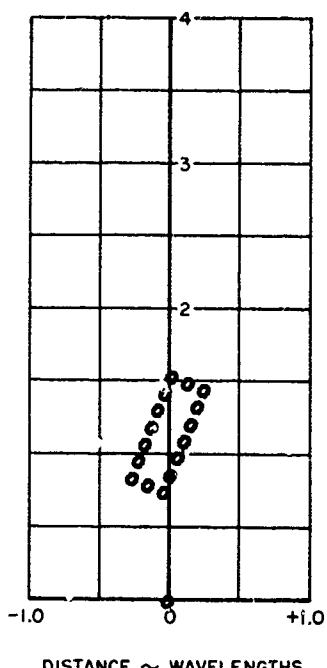
DISTANCE ~ WAVELENGTHS

2-54

DISTANCE ~ WAVELENGTHS

2-53

67

DISTANCE ~ WAVELENGTHS

2-56

DISTANCE ~ WAVELENGTHS

2-55

68

DISTANCE ~ WAVELENGTHS

2-58

DISTANCE ~ WAVELENGTHS

2-57

69

-1.0   0   +1.0

DISTANCE ~ WAVELENGTHS

2-60

-1.0   0   +1.0

DISTANCE ~ WAVELENGTHS

2-59

DISTANCE ~ WAVELENGTHS

2-62

DISTANCE ~ WAVELENGTHS

2-61

71

DISTANCE ~ WAVELENGTHS

2-64

DISTANCE ~ WAVELENGTHS

2-63

72

DISTANCE ~ WAVELENGTHS

2-66

DISTANCE ~ WAVELENGTHS

2-65

73

DISTANCE ~ WAVELENGTHS

2-68

DISTANCE ~ WAVELENGTHS

2-67

74
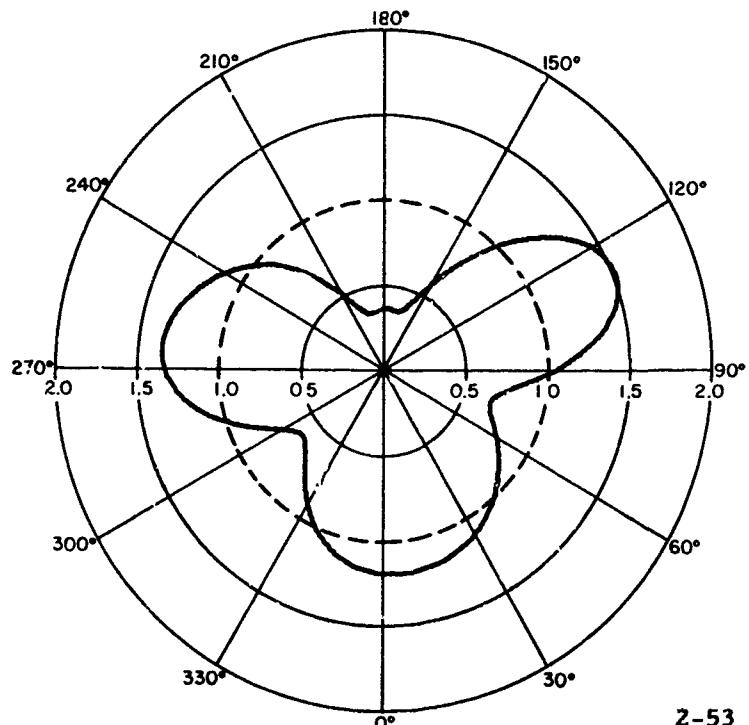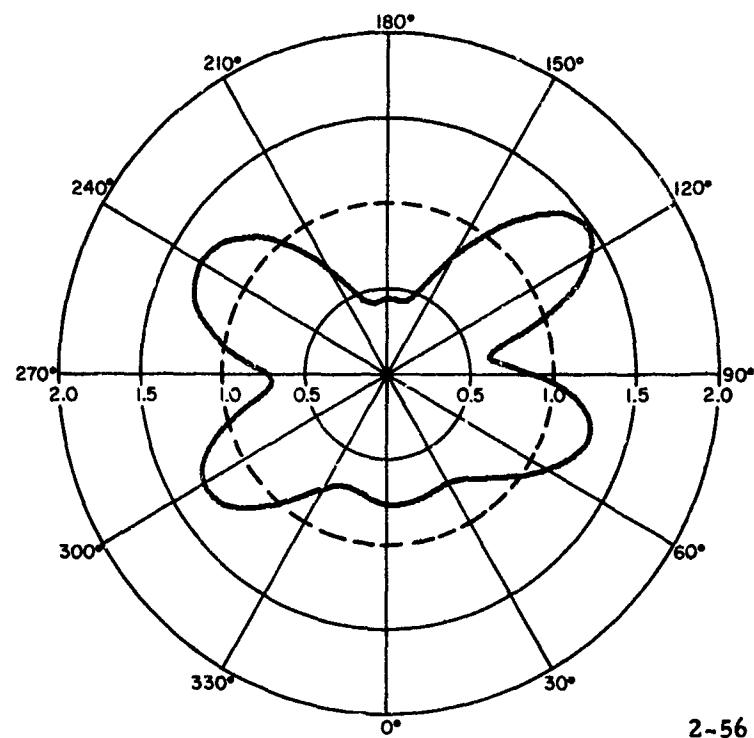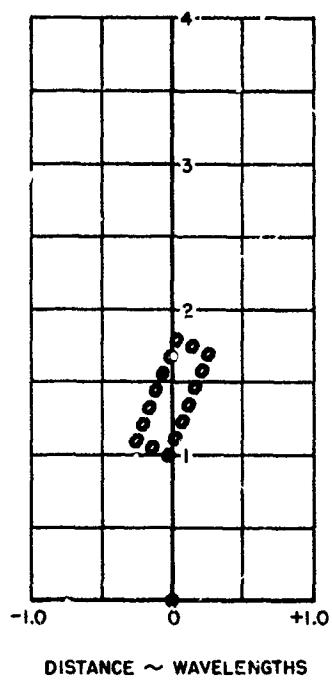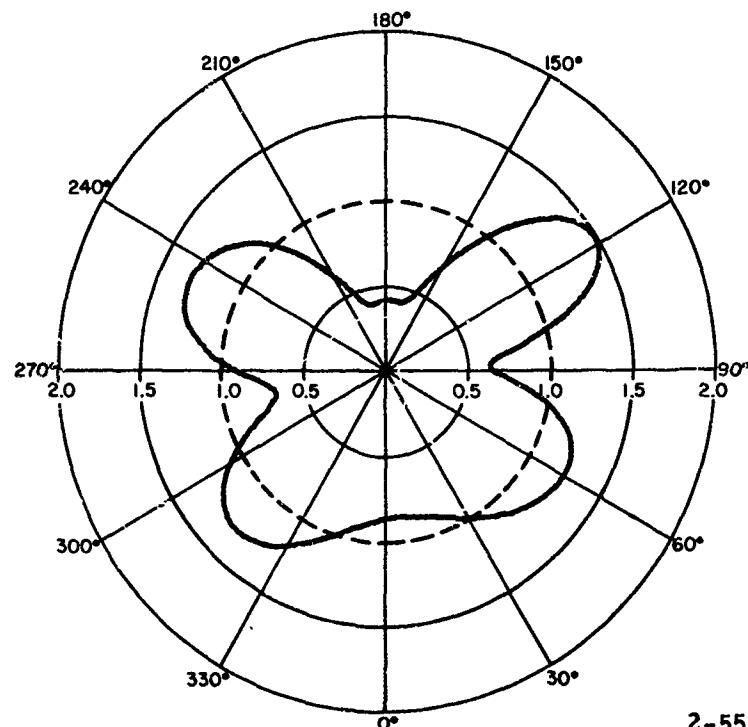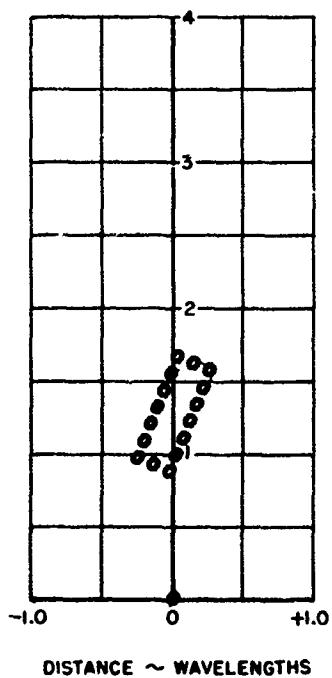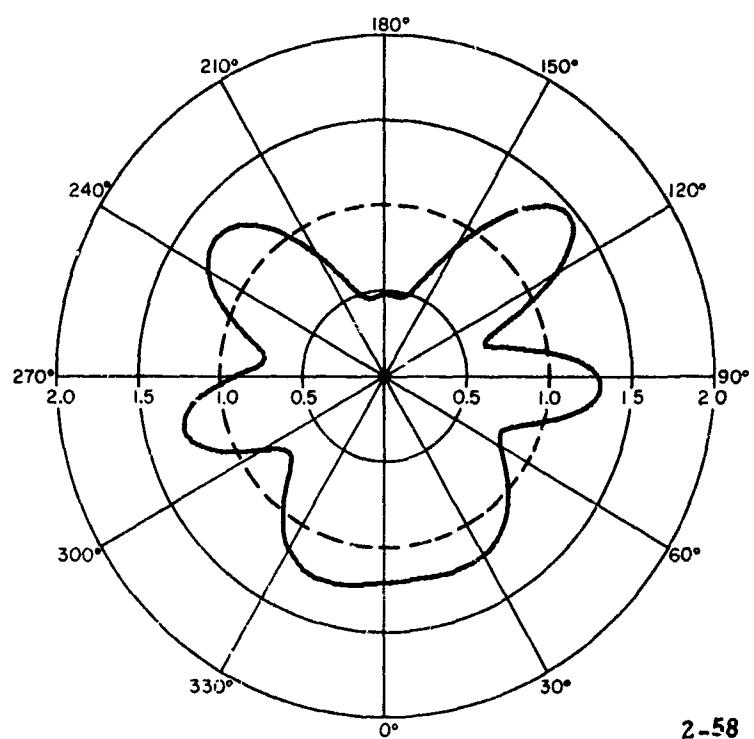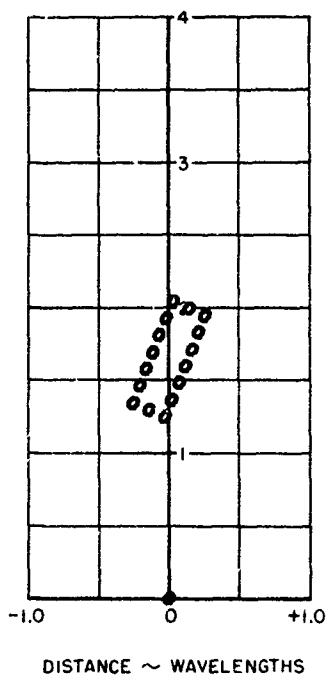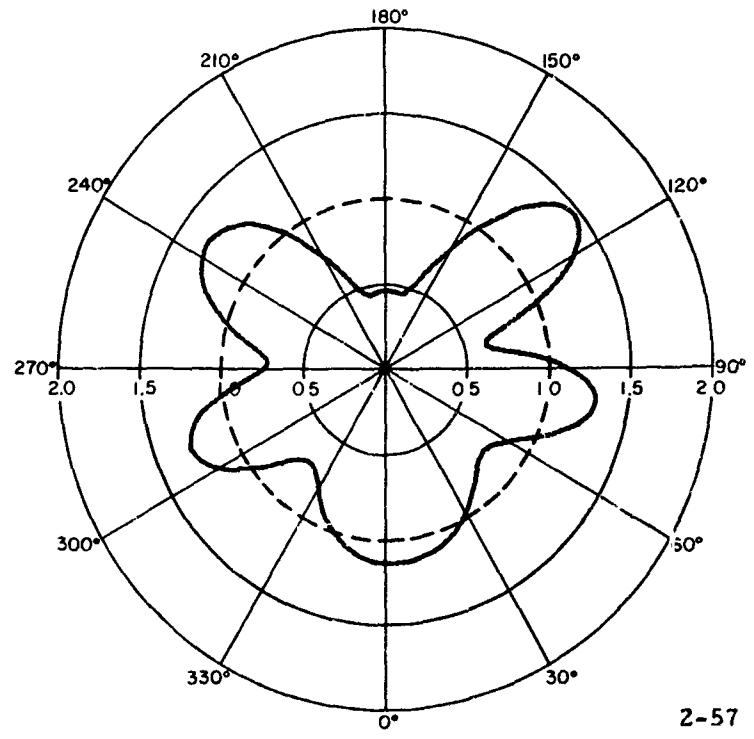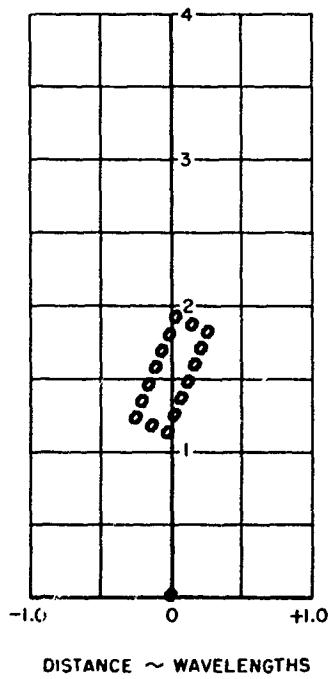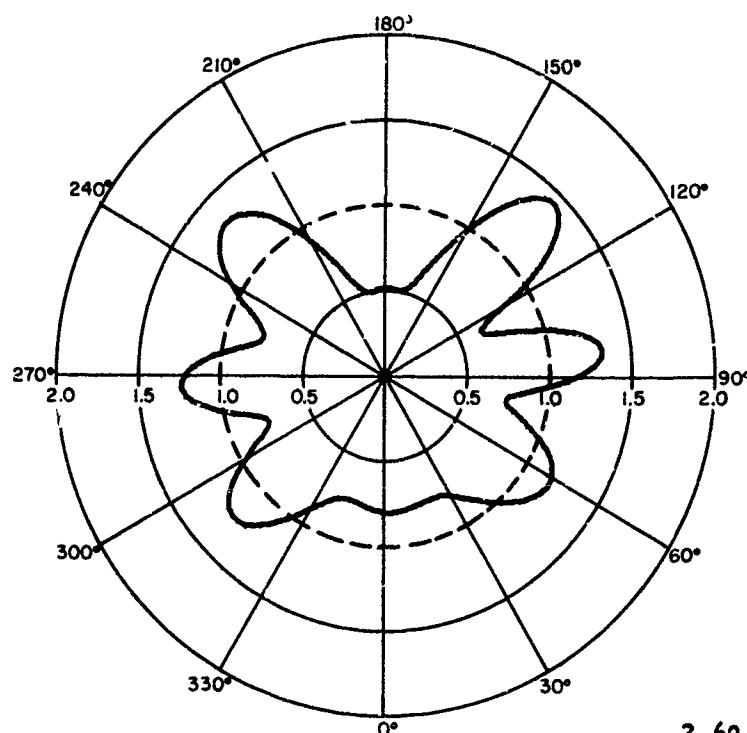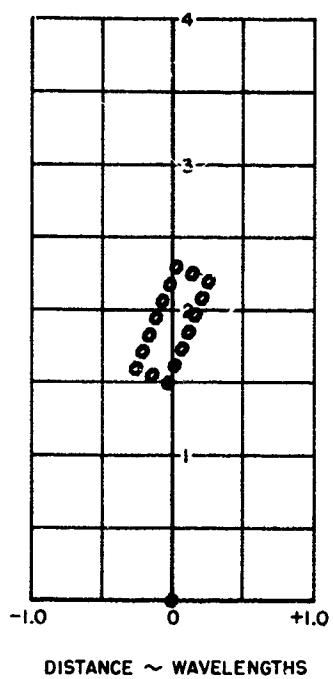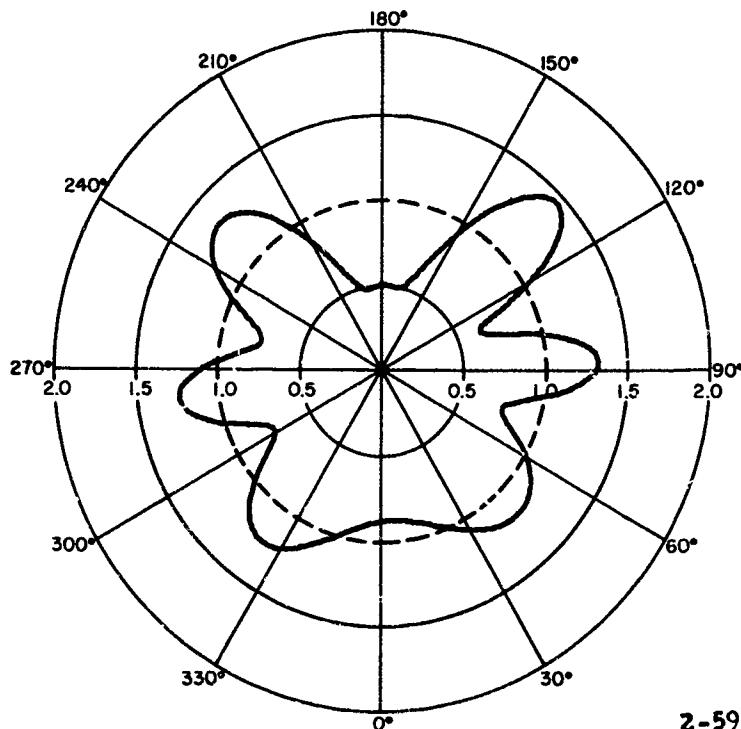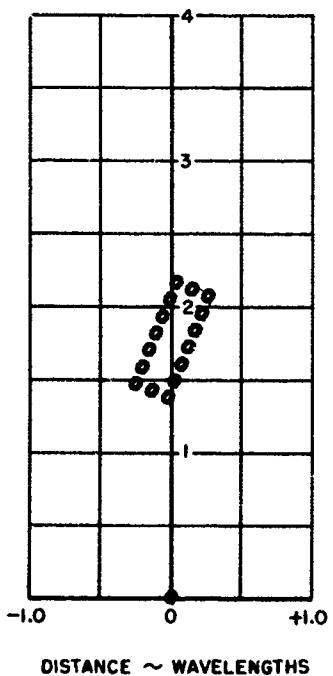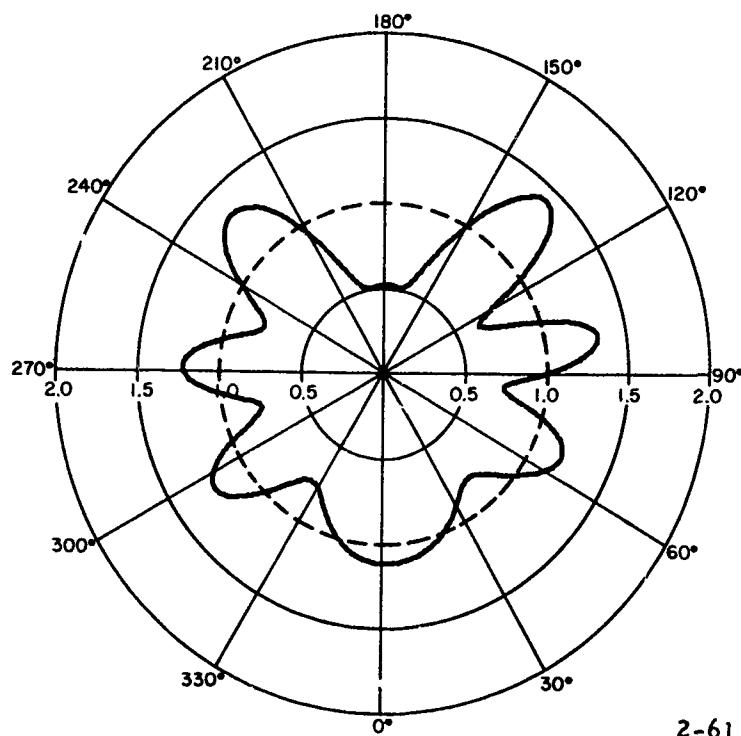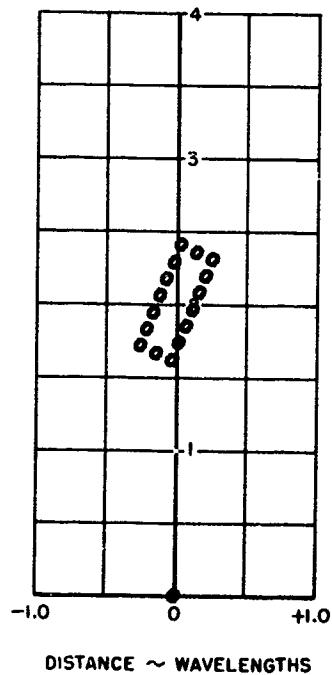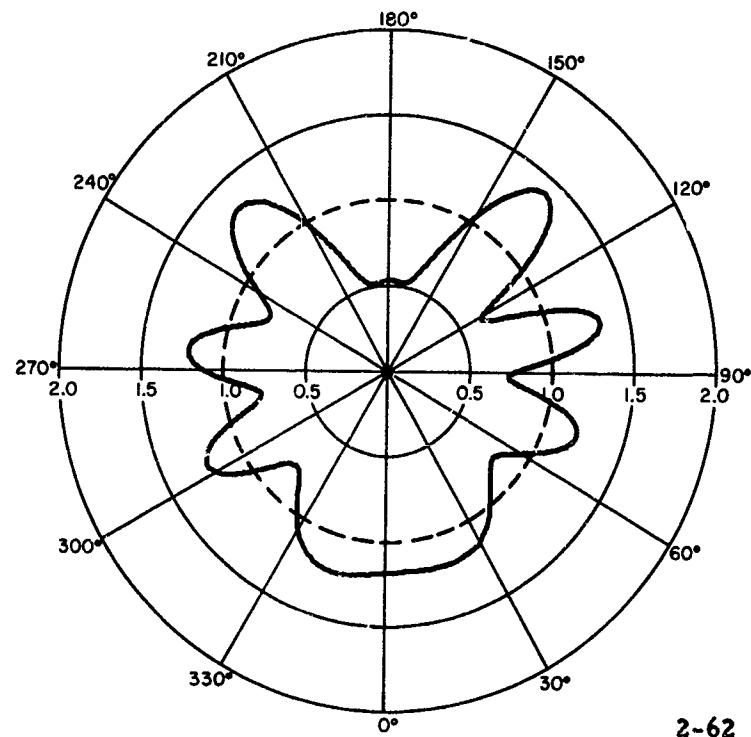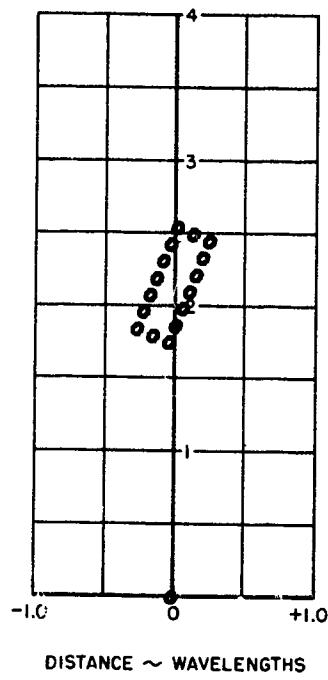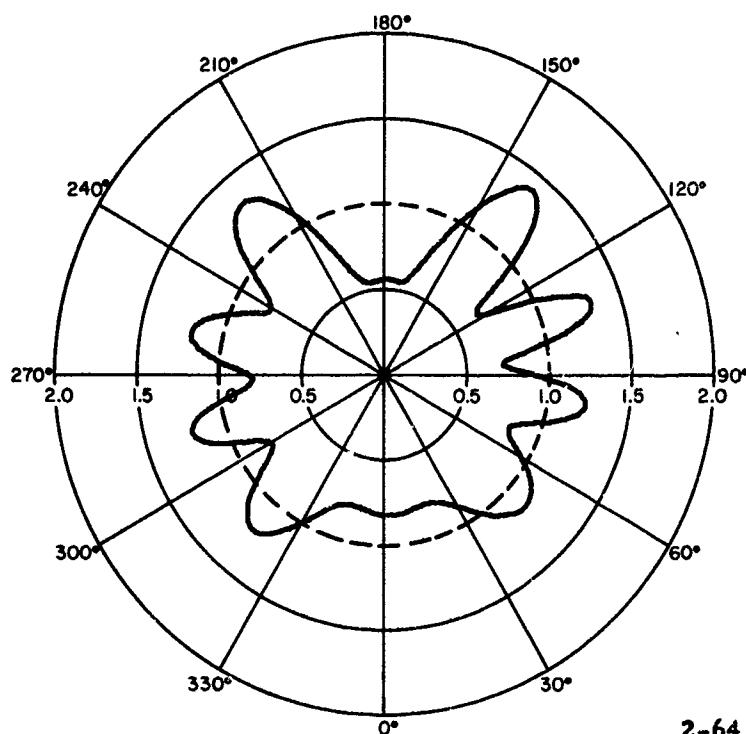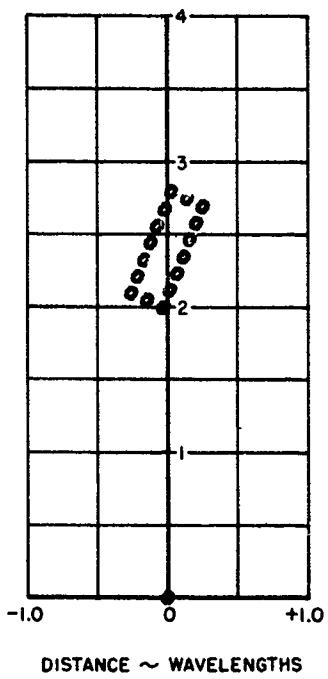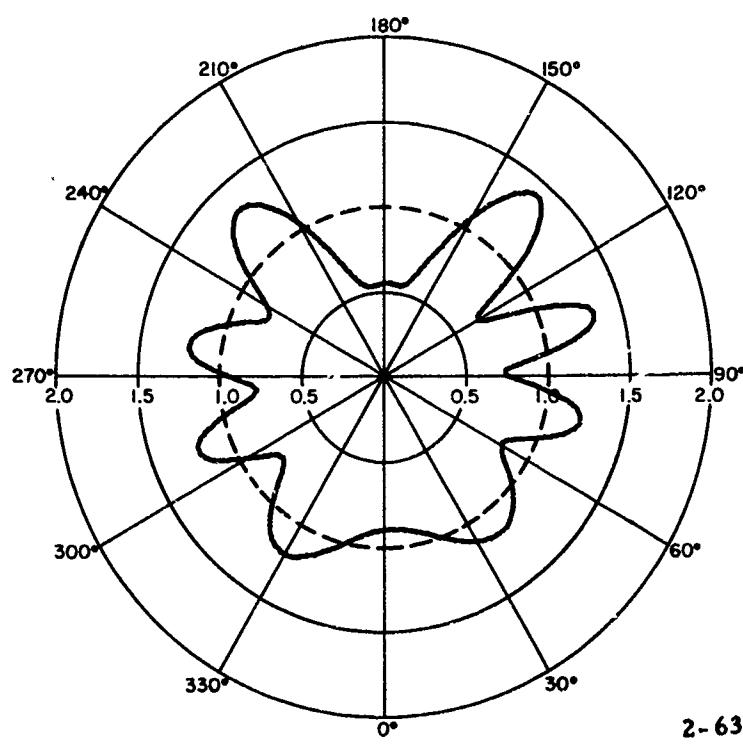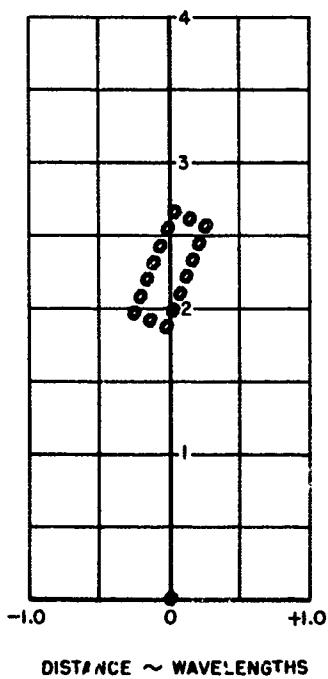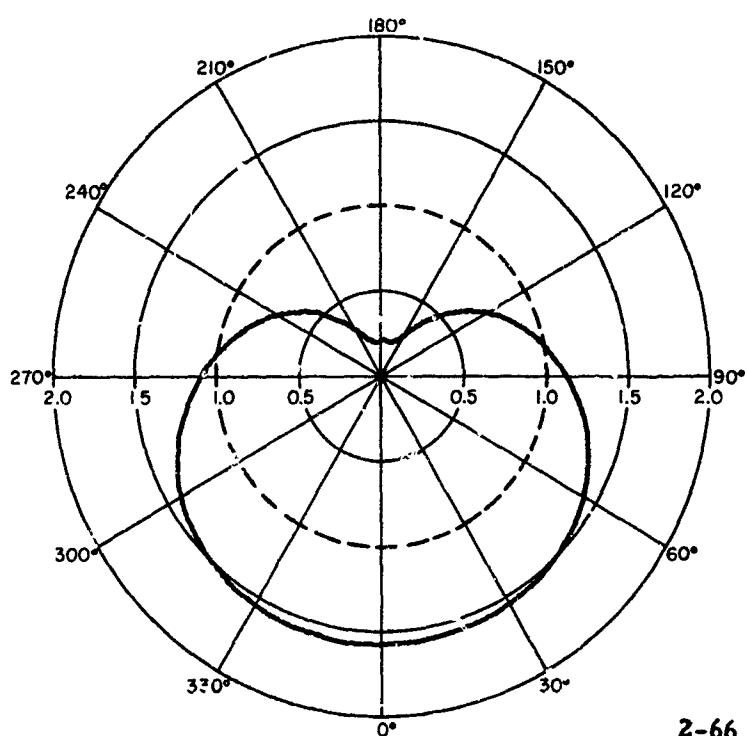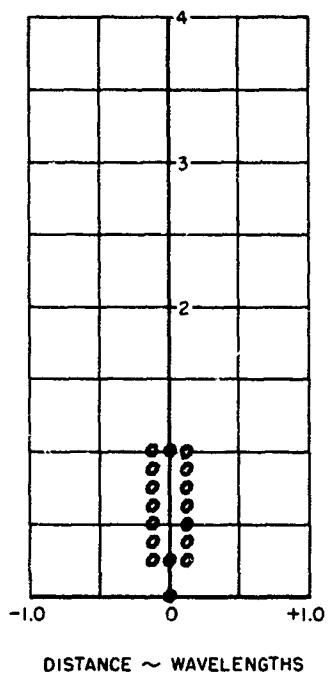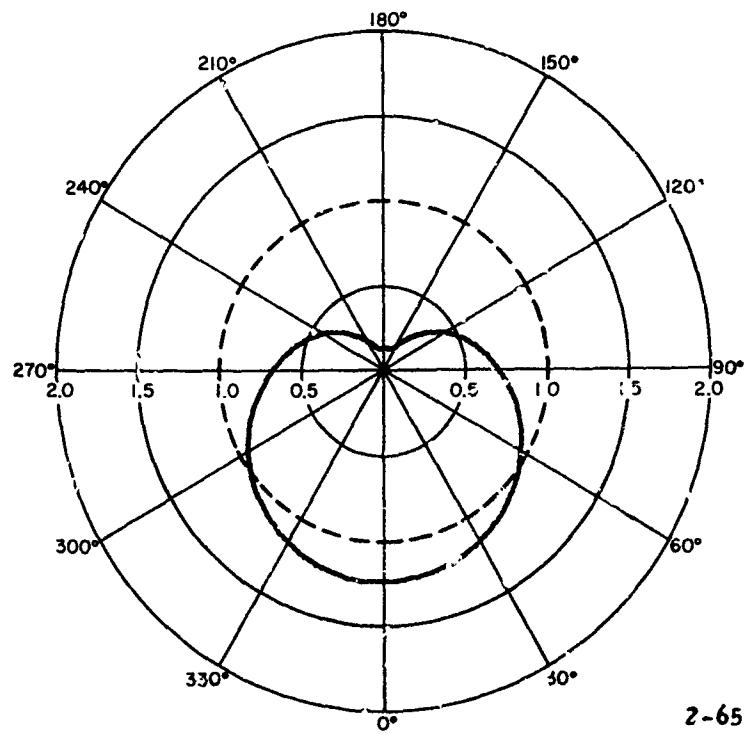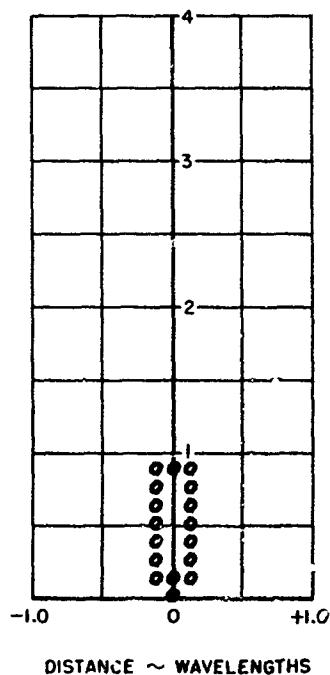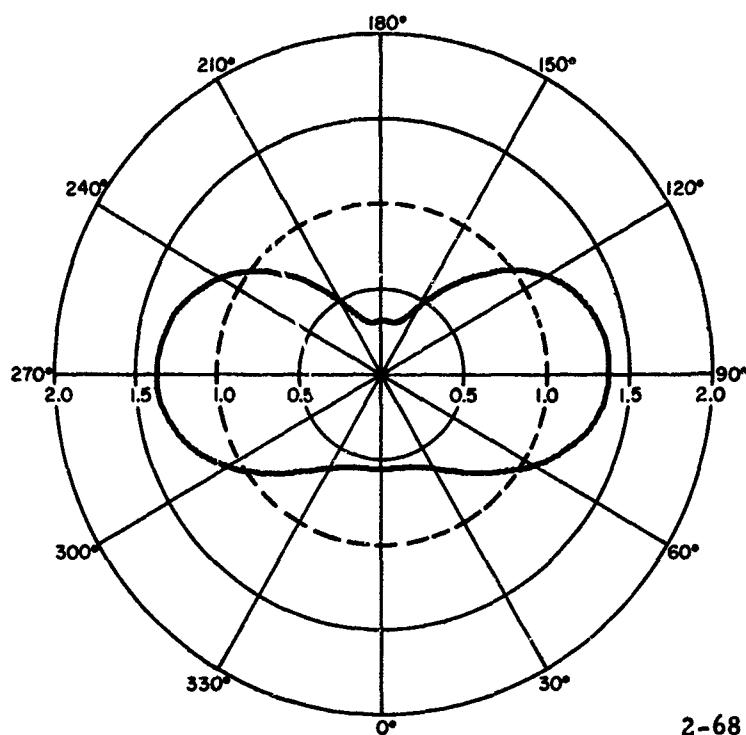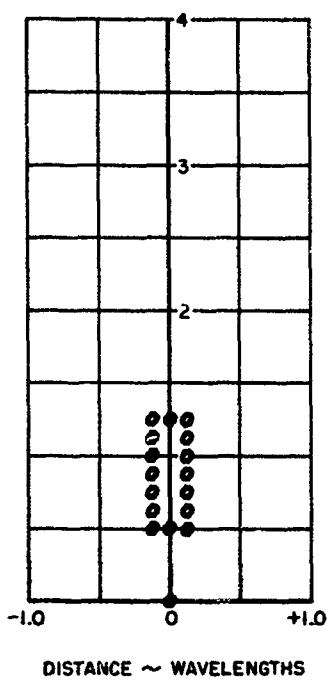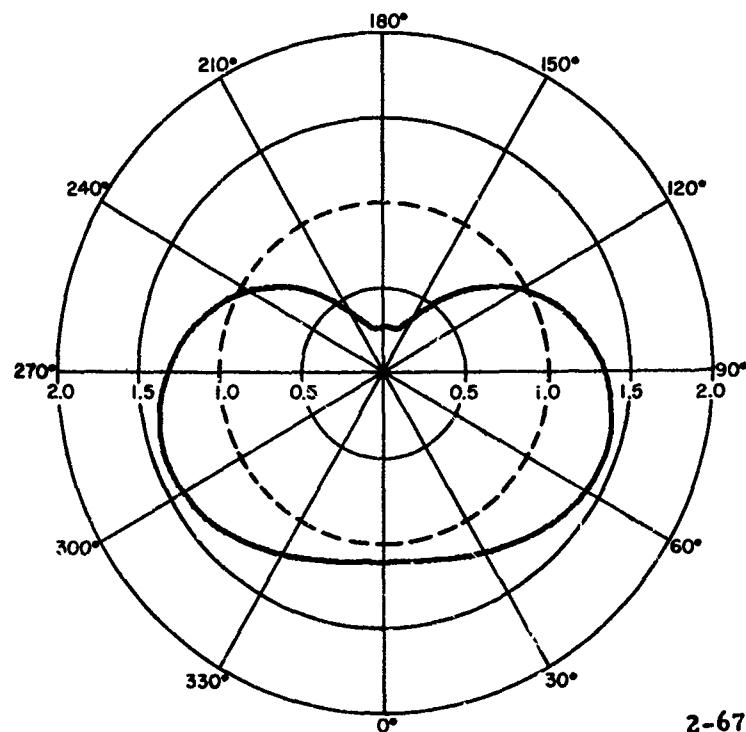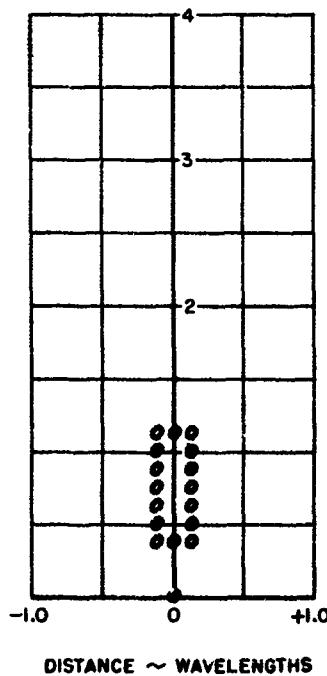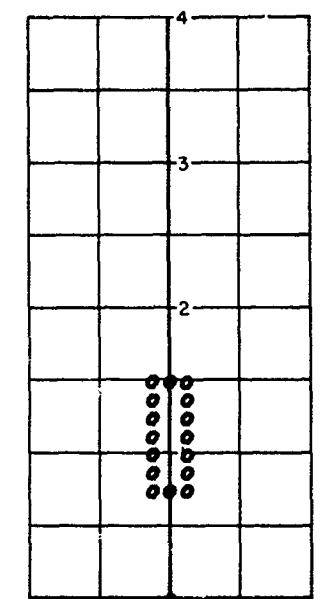
DISTANCE ~ WAVELENGTHS

2-70

DISTANCE ~ WAVELENGTHS

2-69

75

DISTANCE ~ WAVELENGTHS

2-72

DISTANCE ~ WAVELENGTHS

2-71

76
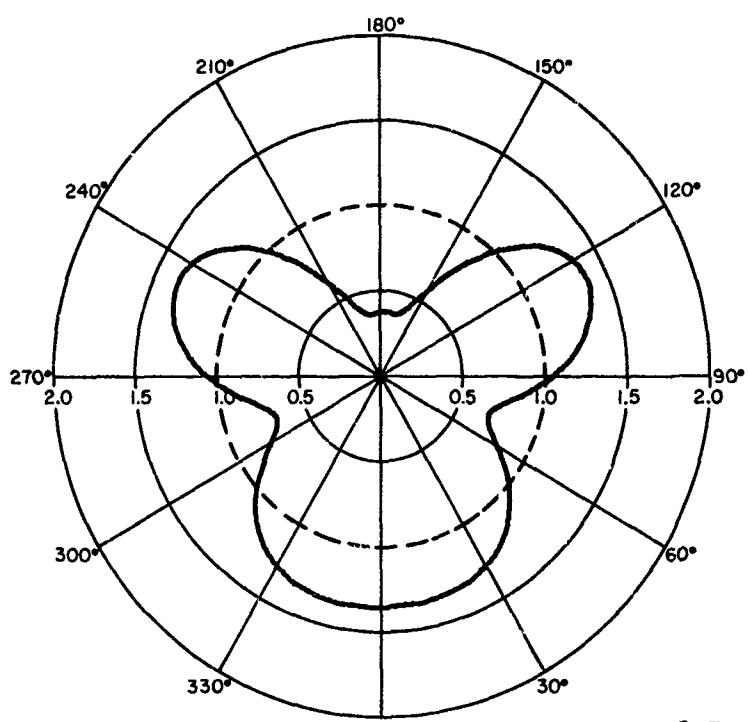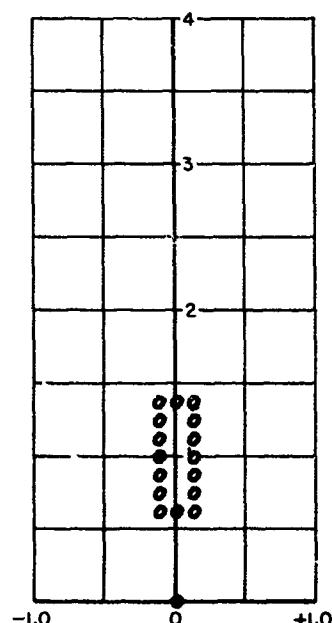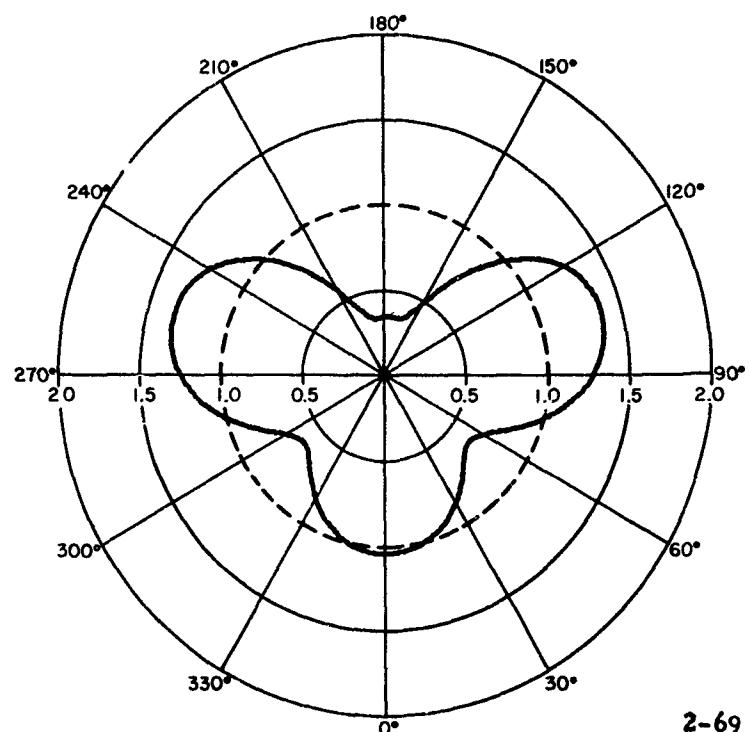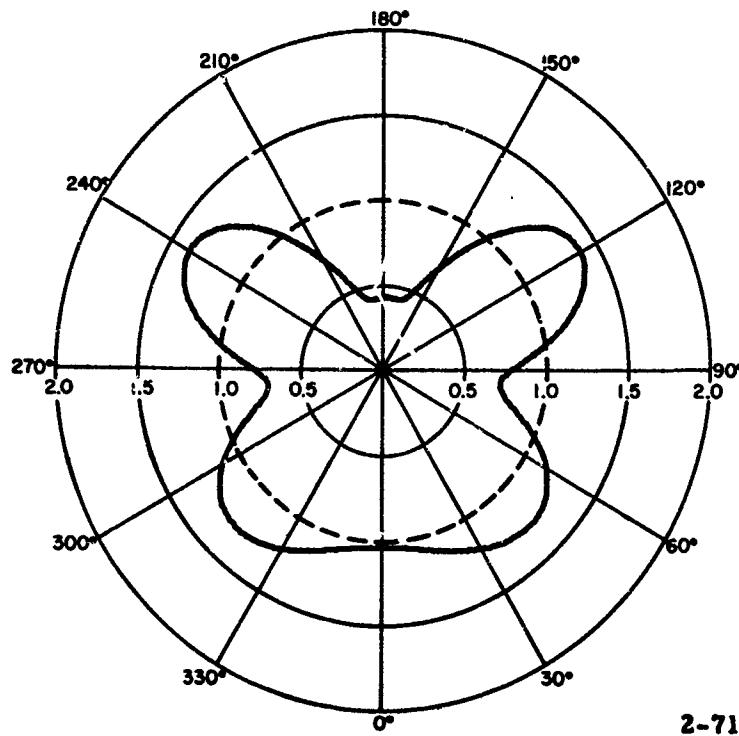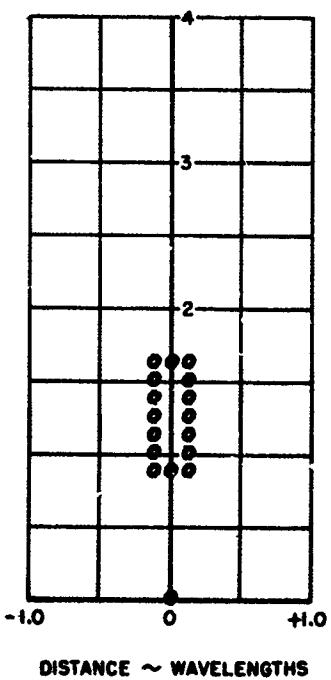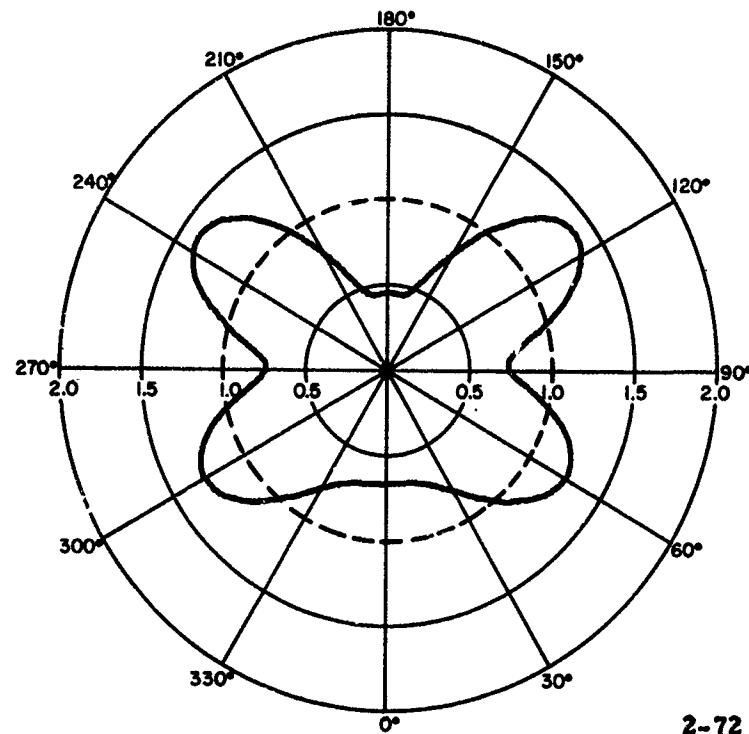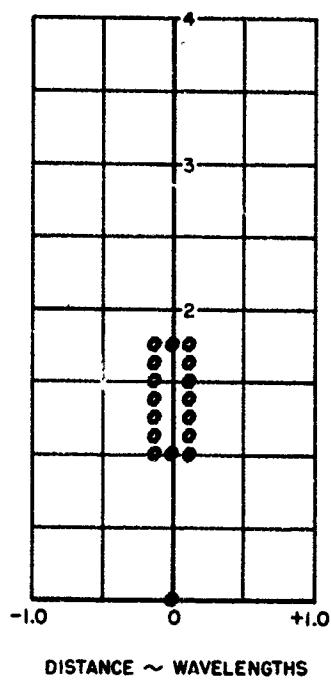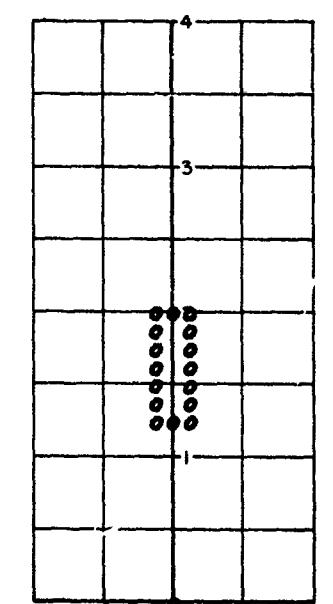
DISTANCE ~ WAVELENGTHS

2-74

DISTANCE ~ WAVELENGTHS

2-73

77

DISTANCE ~ WAVELENGTHS

2-76

DISTANCE ~ WAVELENGTHS

2-75

78

DISTANCE ~ WAVELENGTHS

2-78

DISTANCE ~ WAVELENGTHS

2-77

79

DISTANCE ~ WAVELENGTHS

2-80


DISTANCE ~ WAVELENGTHS

2-79

80

DISTANCE ~ WAVELENGTHS

3-2

DISTANCE ~ WAVELENGTHS

3-1

81

DISTANCE ~ WAVELENGTHS

3-4

DISTANCE ~ WAVELENGTHS

3-3

82
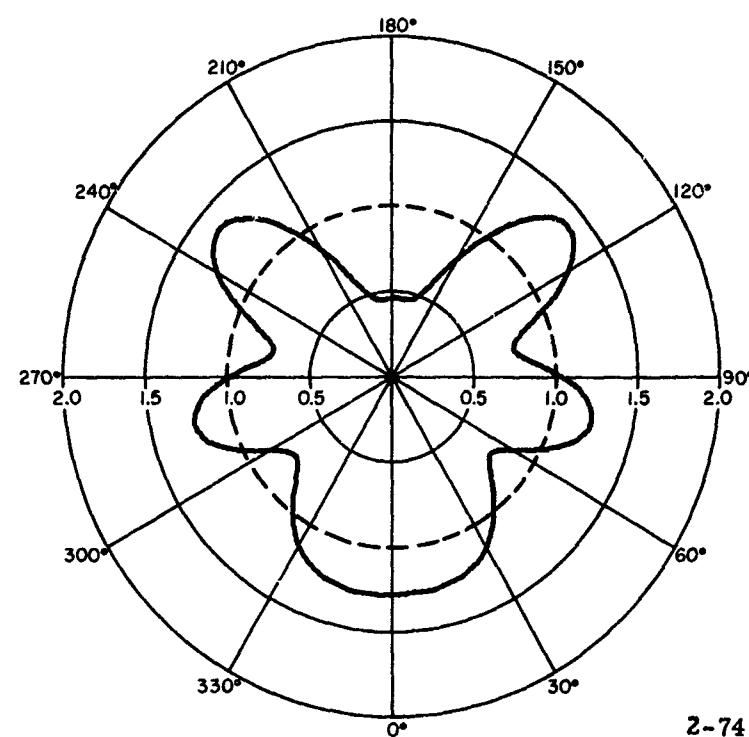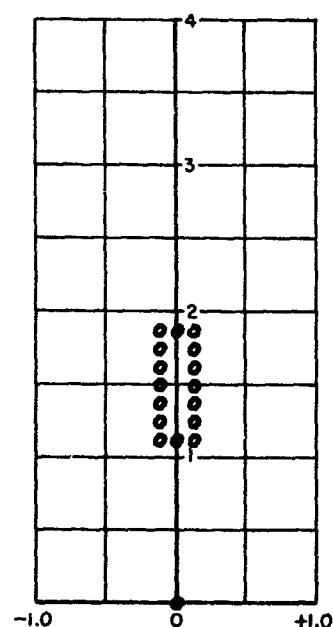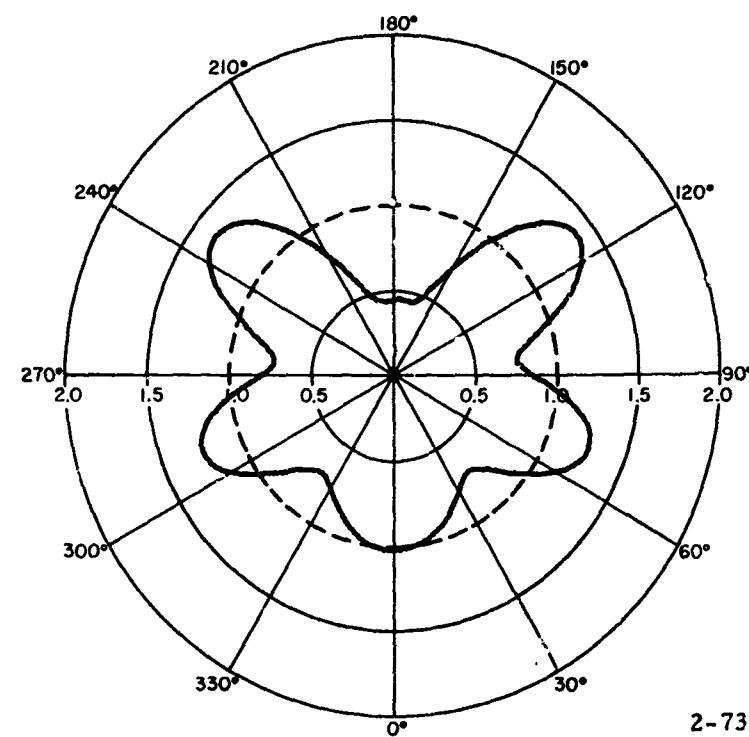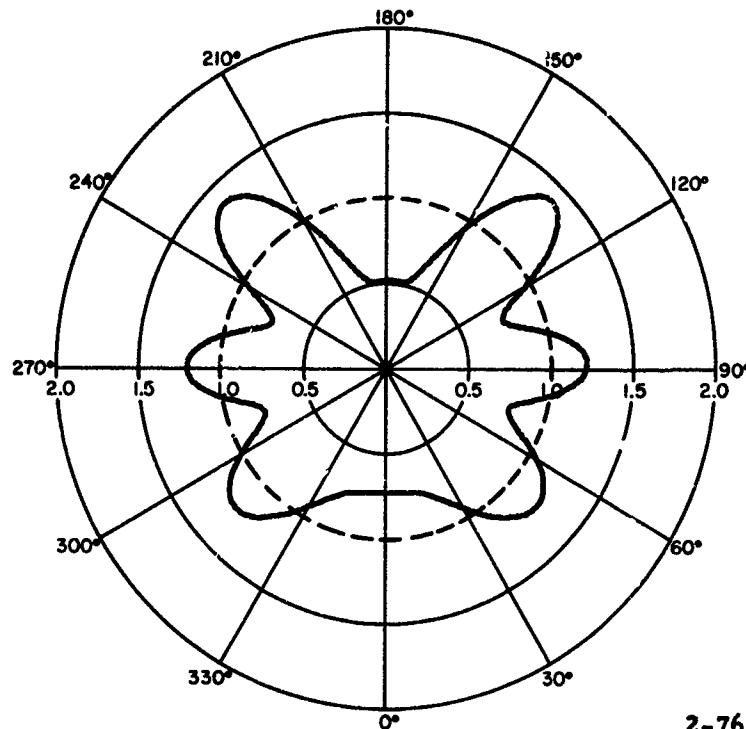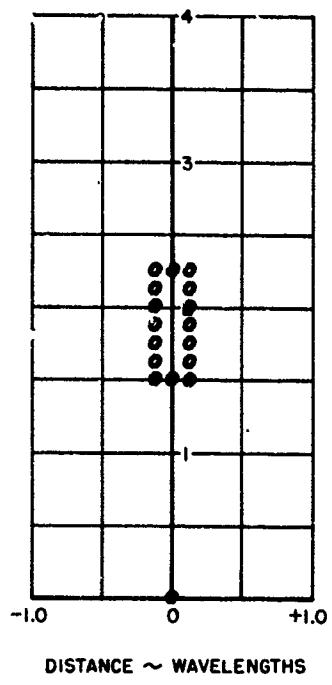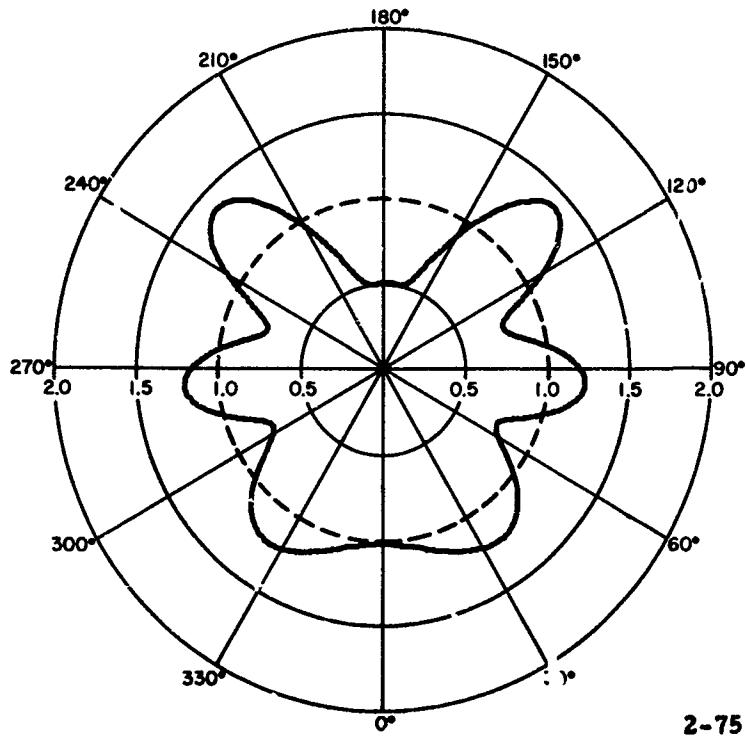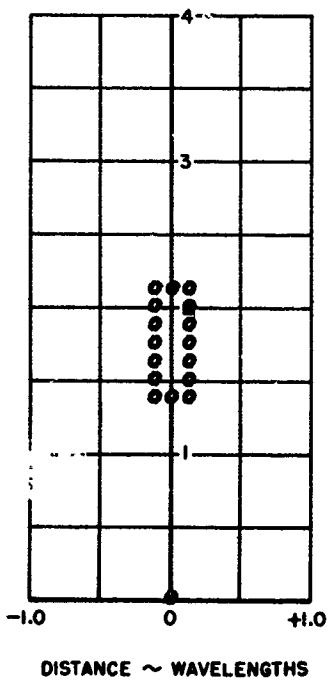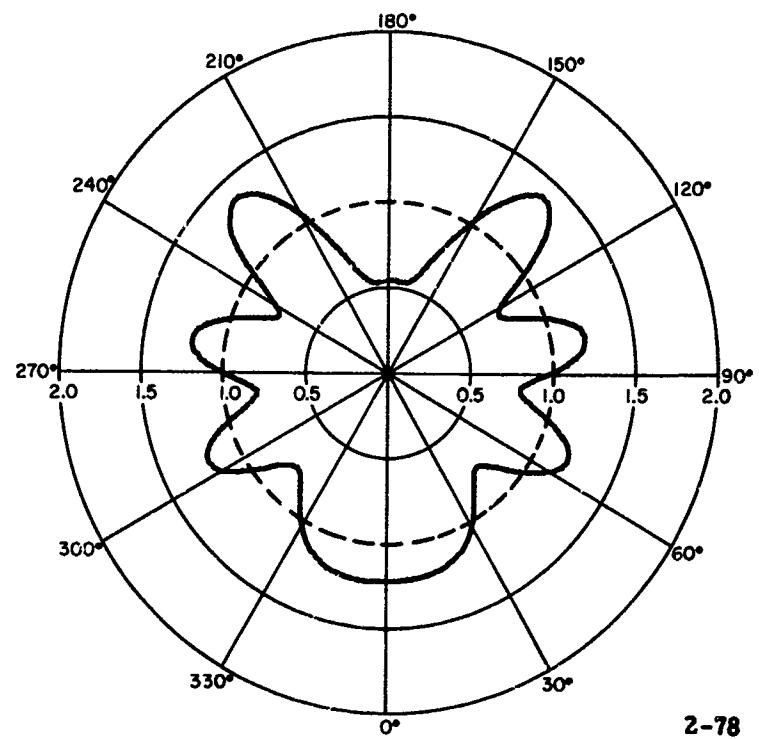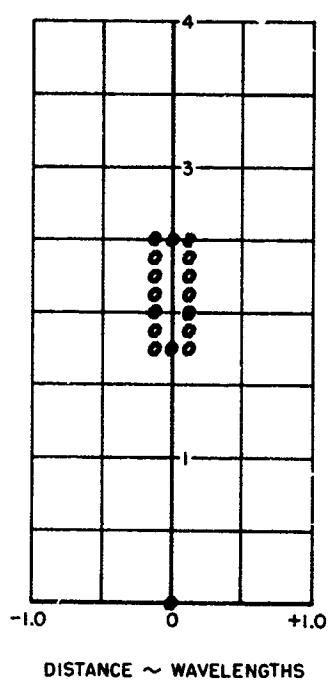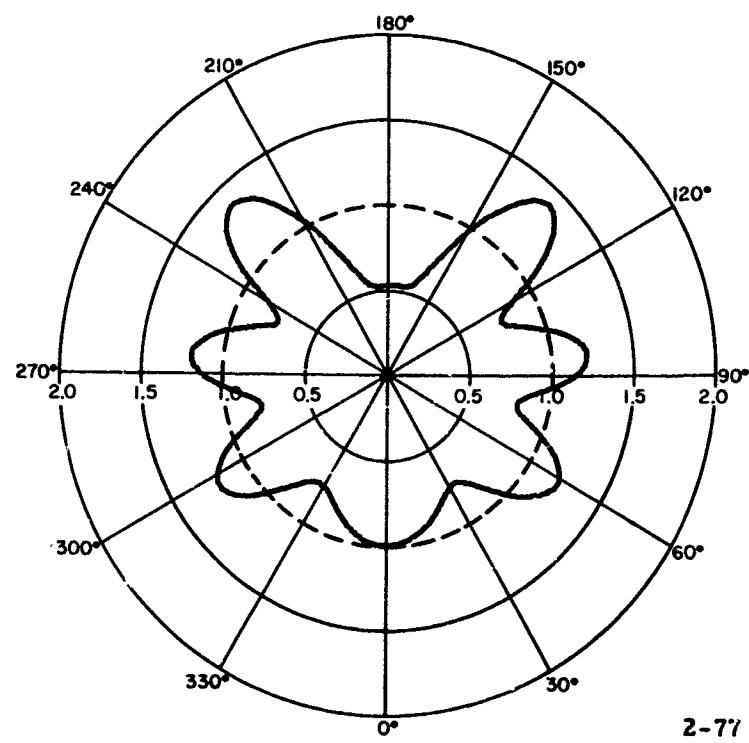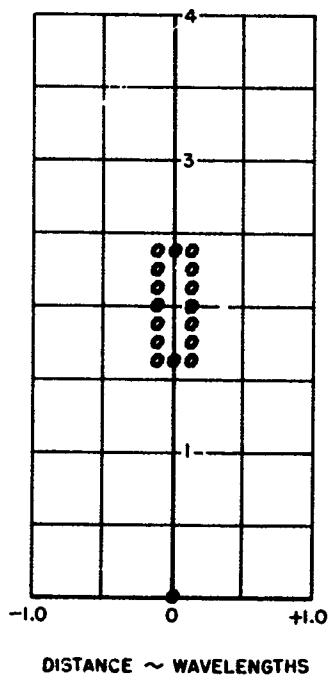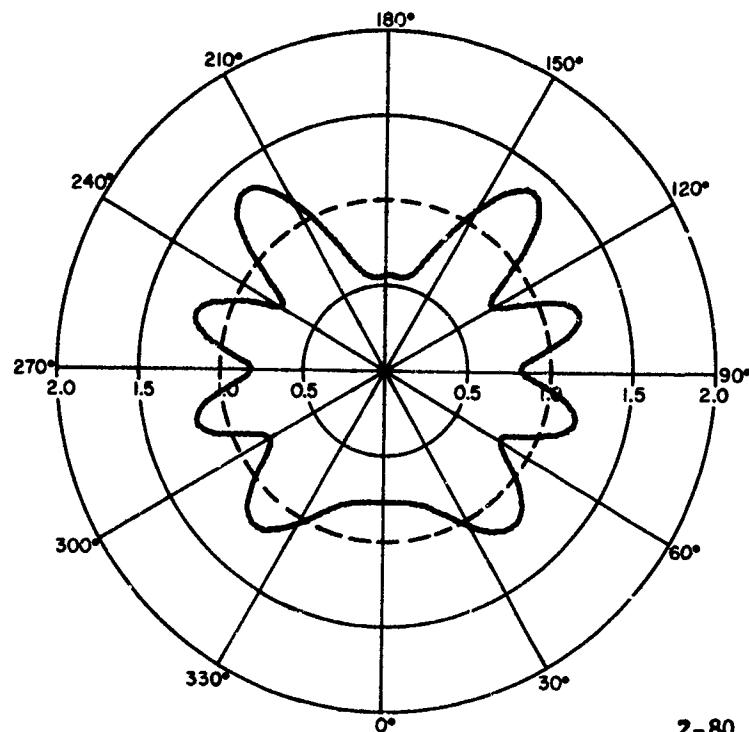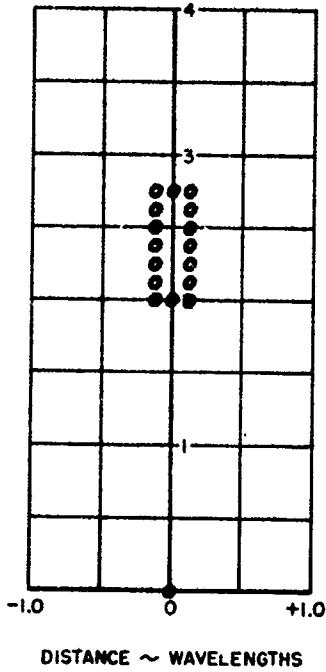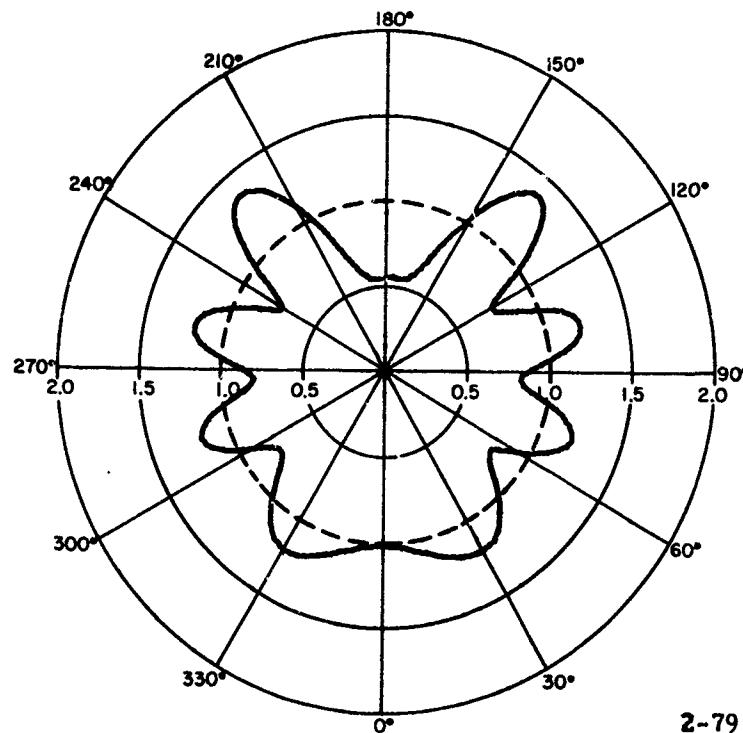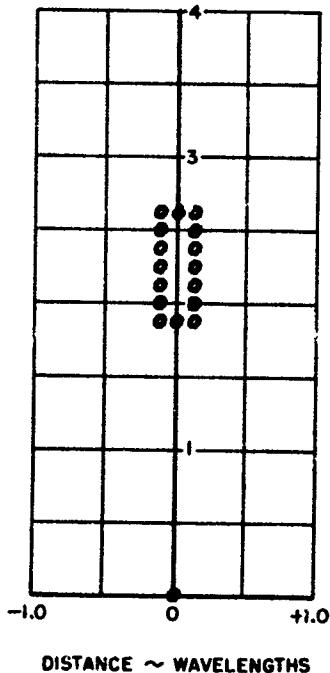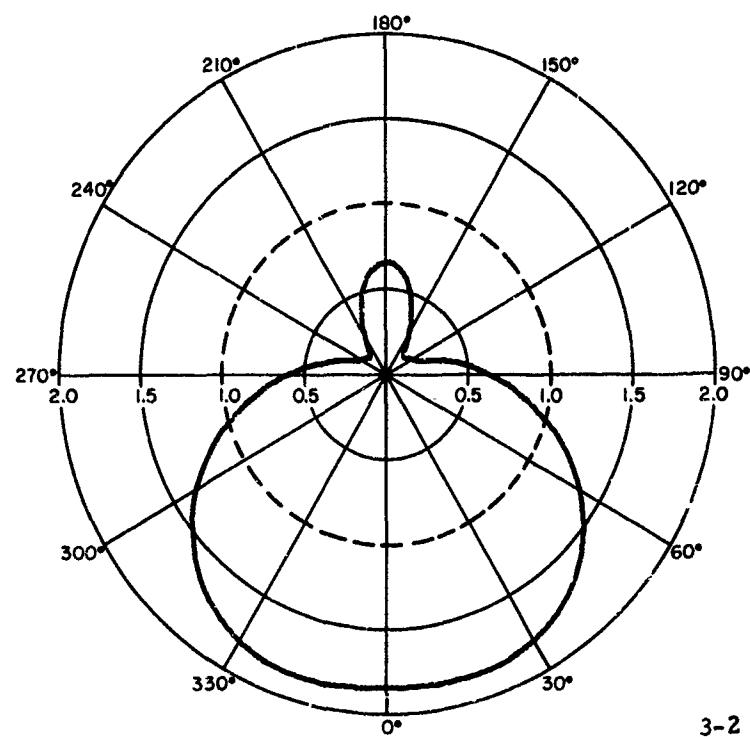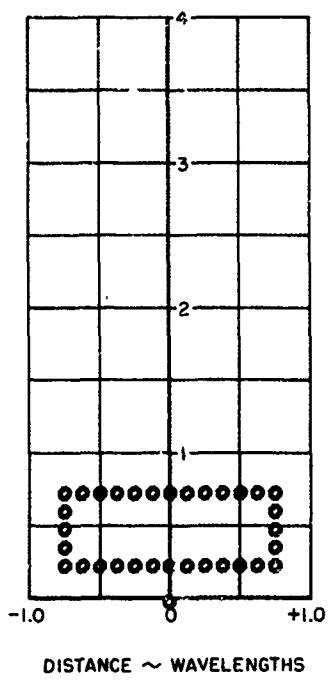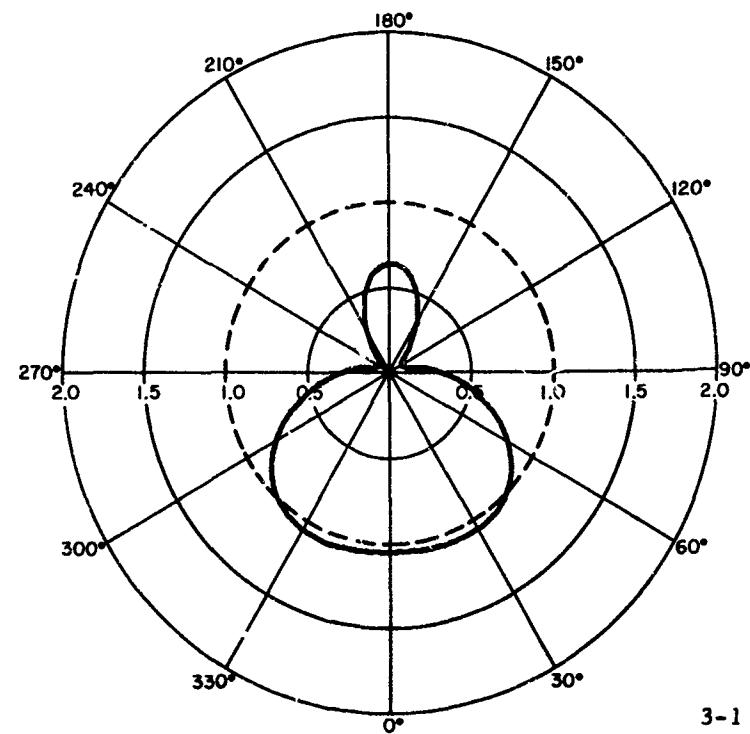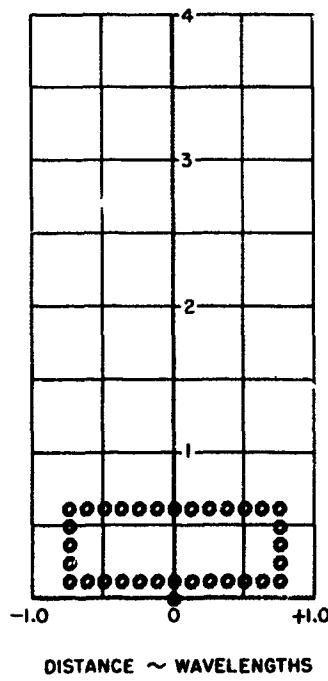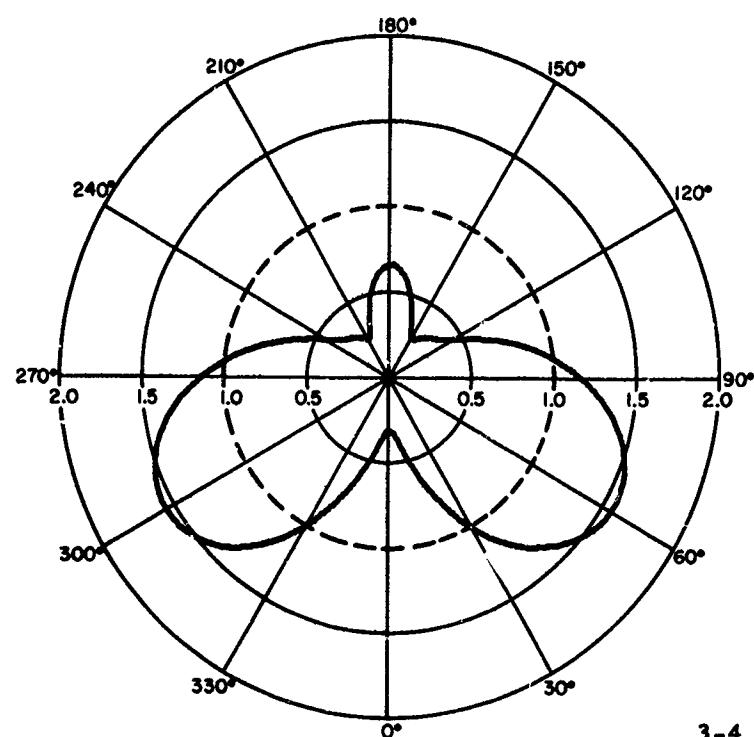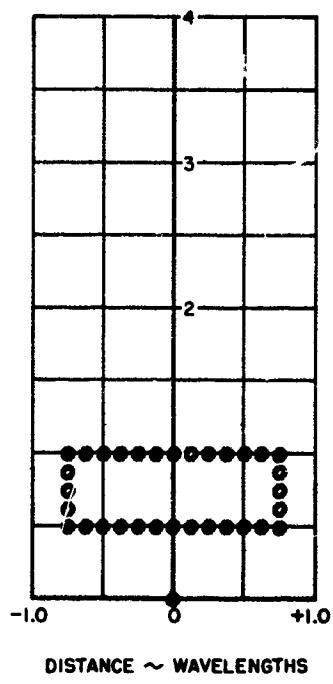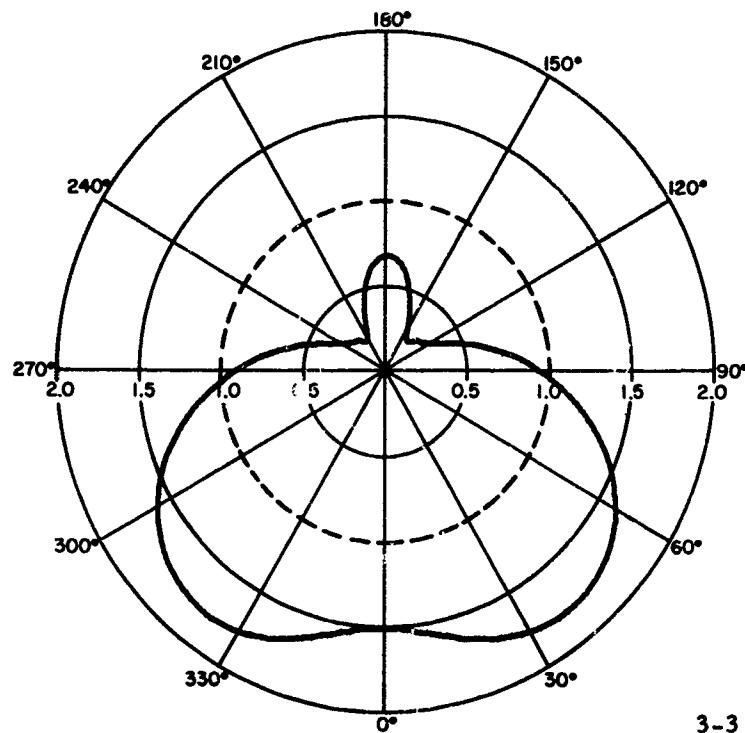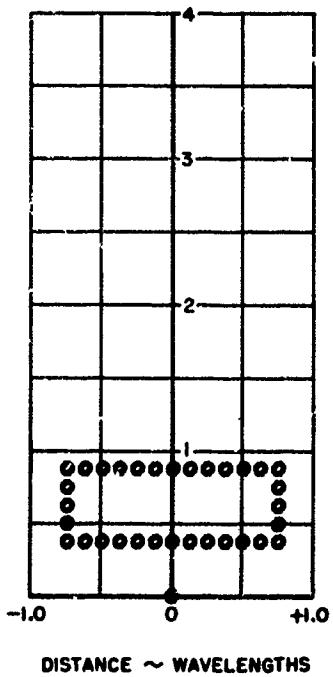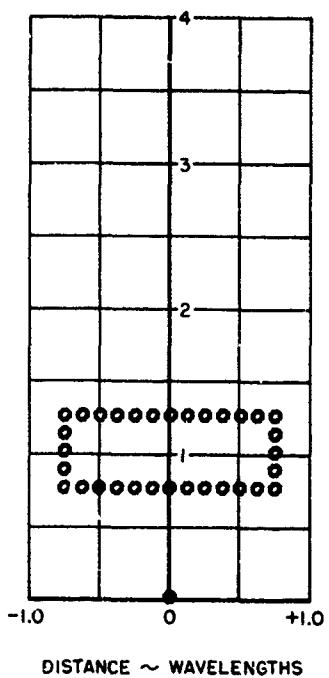
DISTANCE ~ WAVELENGTHS

3-6

DISTANCE ~ WAVELENGTHS

3-5

83
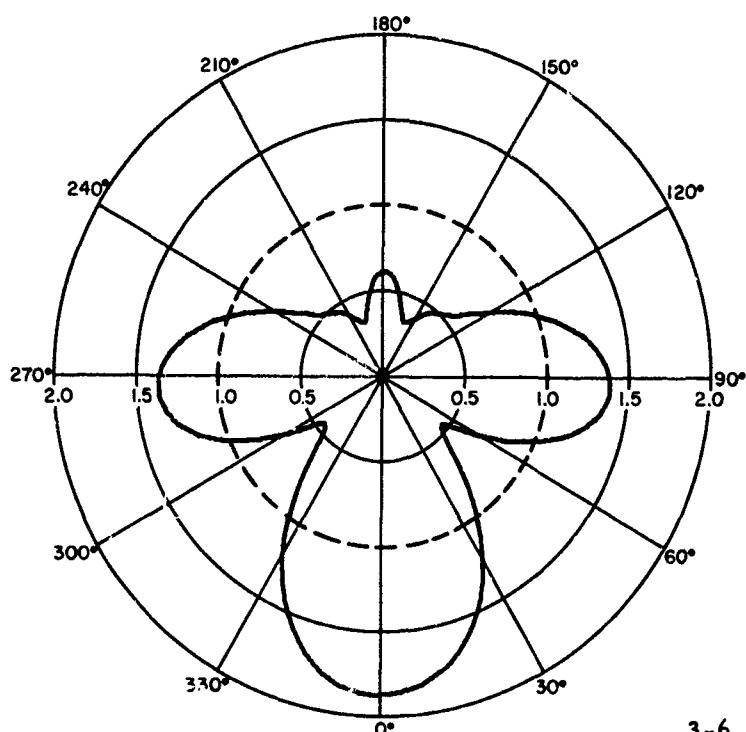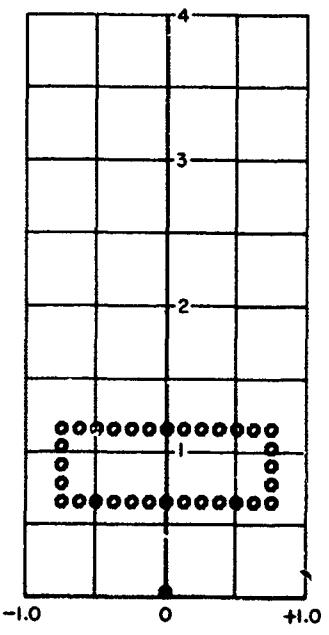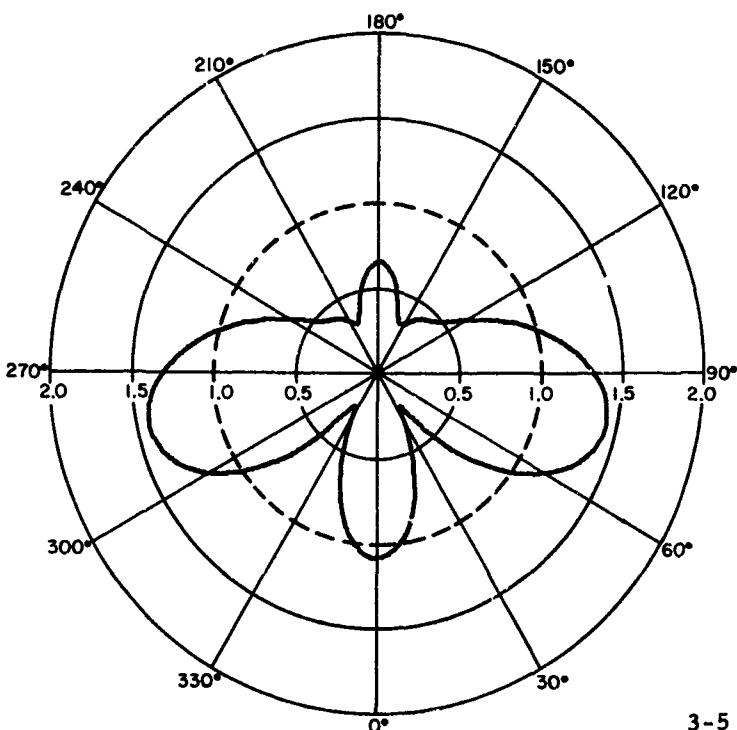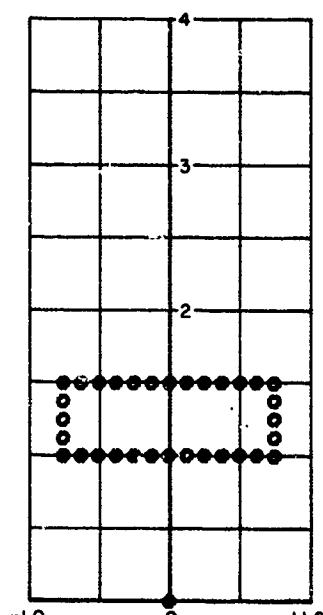
DISTANCE ~ WAVELENGTHS

3-8

DISTANCE ~ WAVELENGTHS

3-7

84
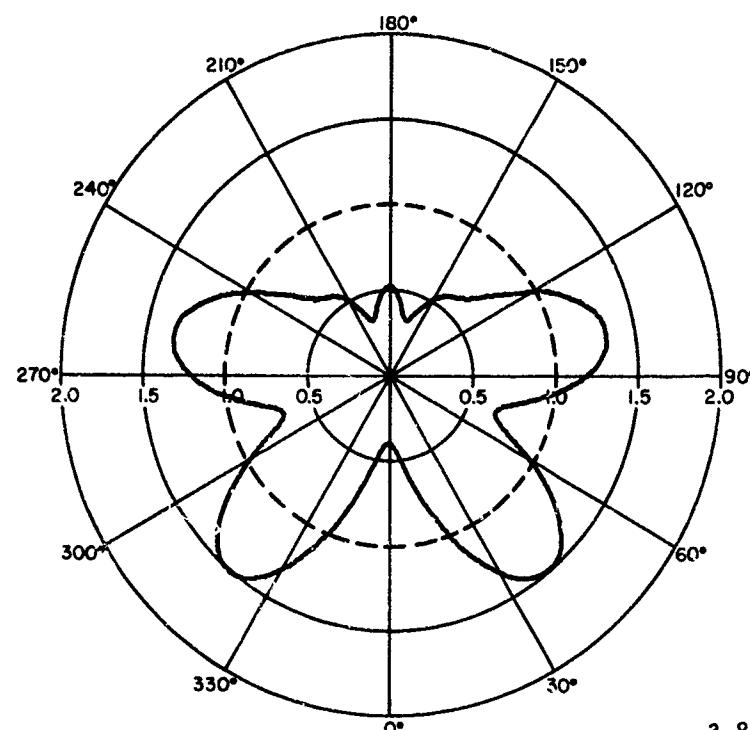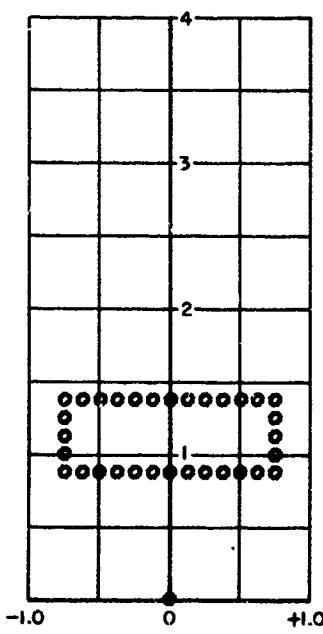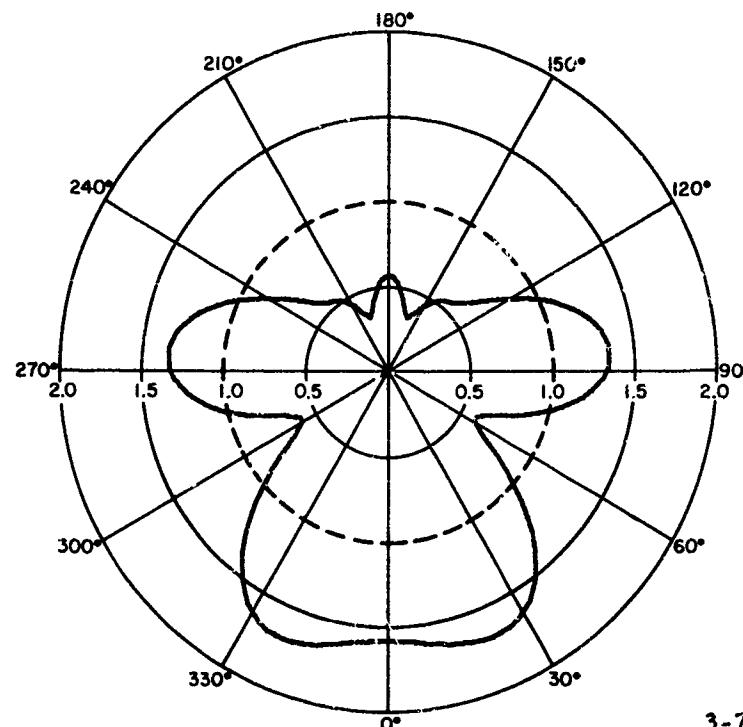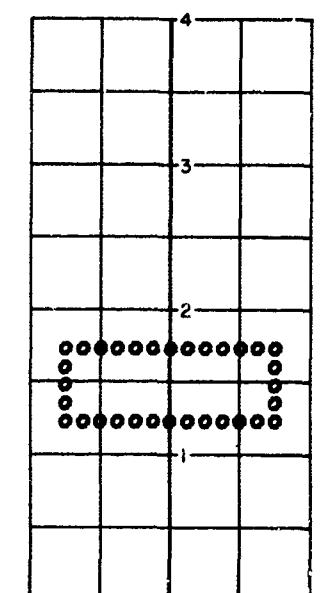
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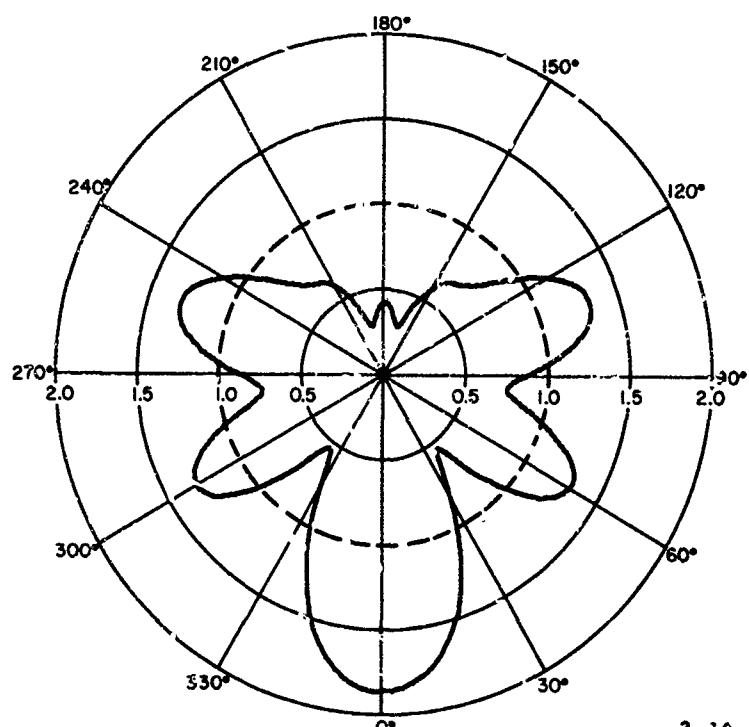
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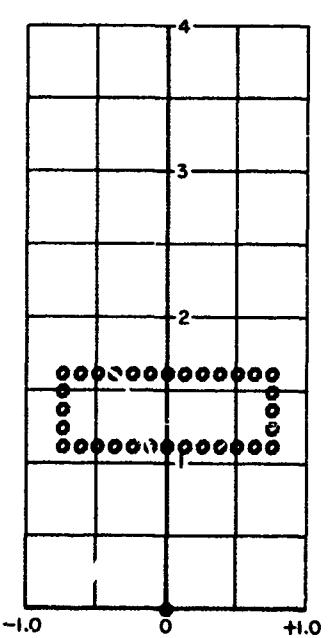
DISTANCE ~ WAVELENGTHS

3-9

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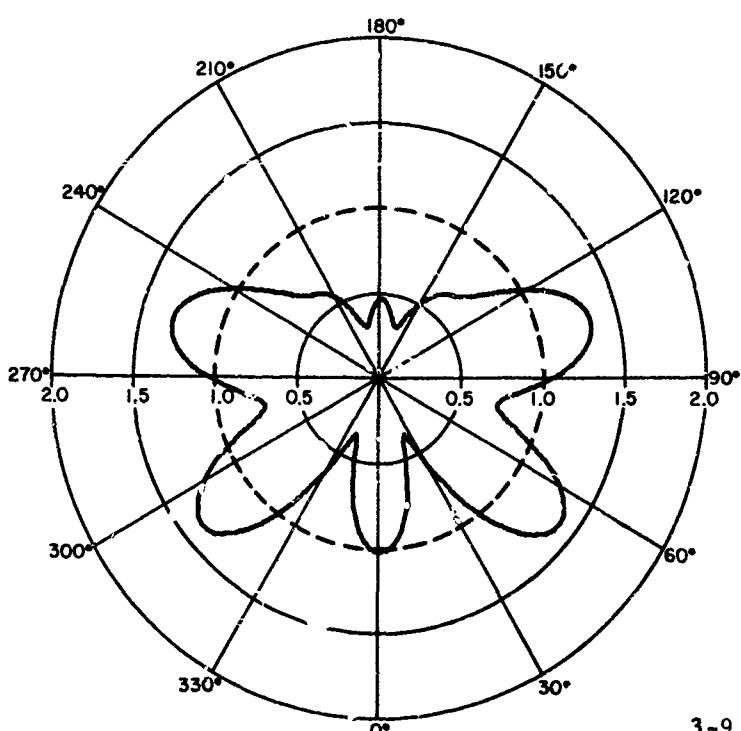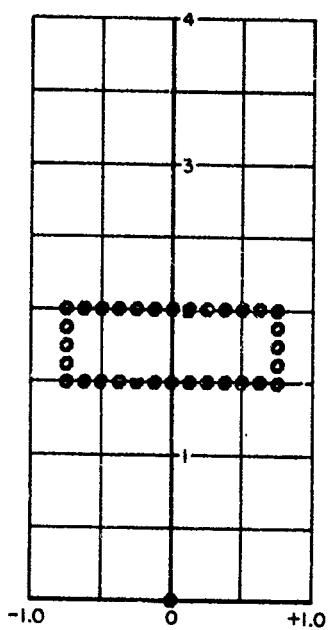
DISTANCE ~ WAVELENGTHS

3-12

DISTANCE ~ WAVELENGTHS

3-11

86

DISTANCE ~ WAVELENGTHS

3-14

DISTANCE ~ WAVELENGTHS

3-13

87

DISTANCE ~ WAVELENGTHS

3-16

DISTANCE ~ WAVELENGTHS

3-15

88
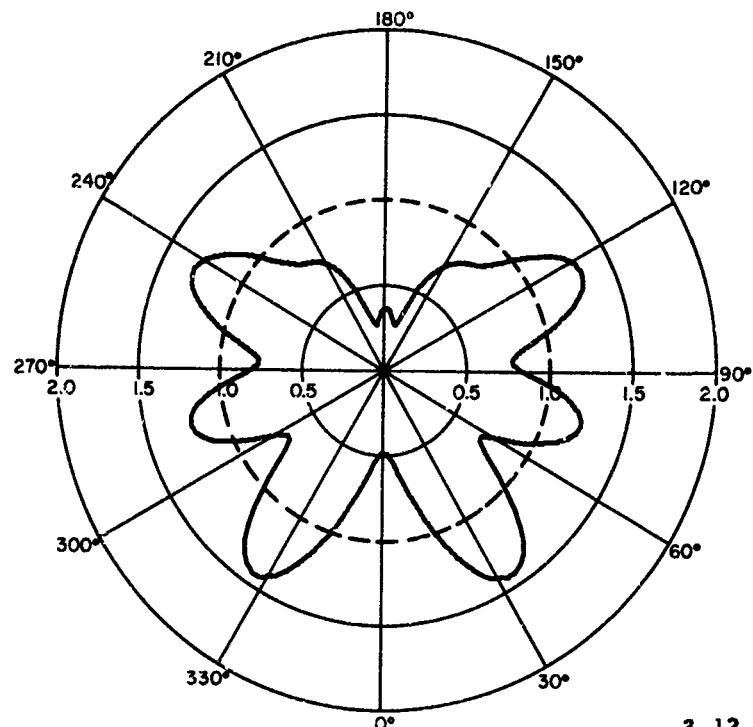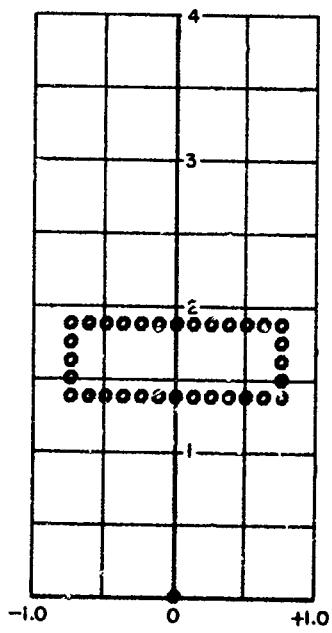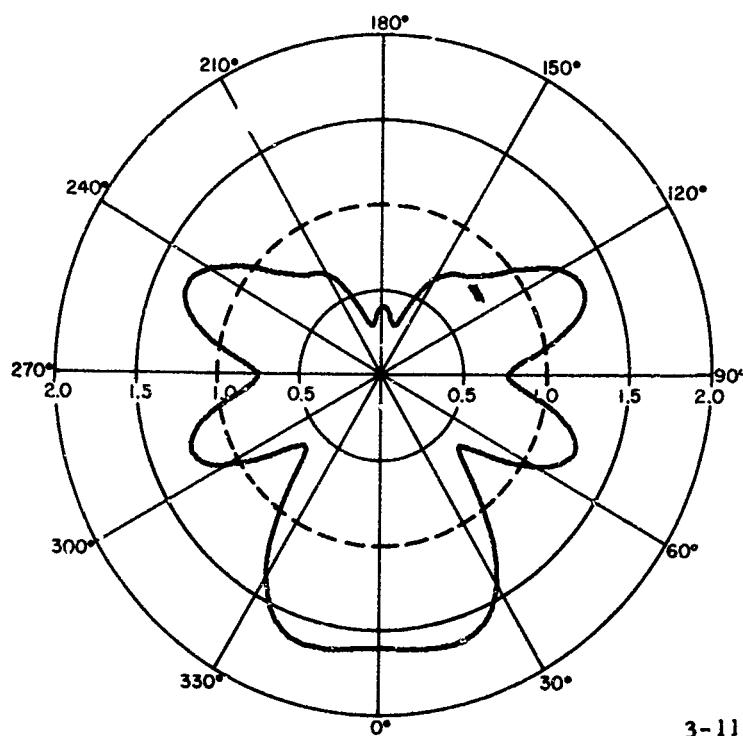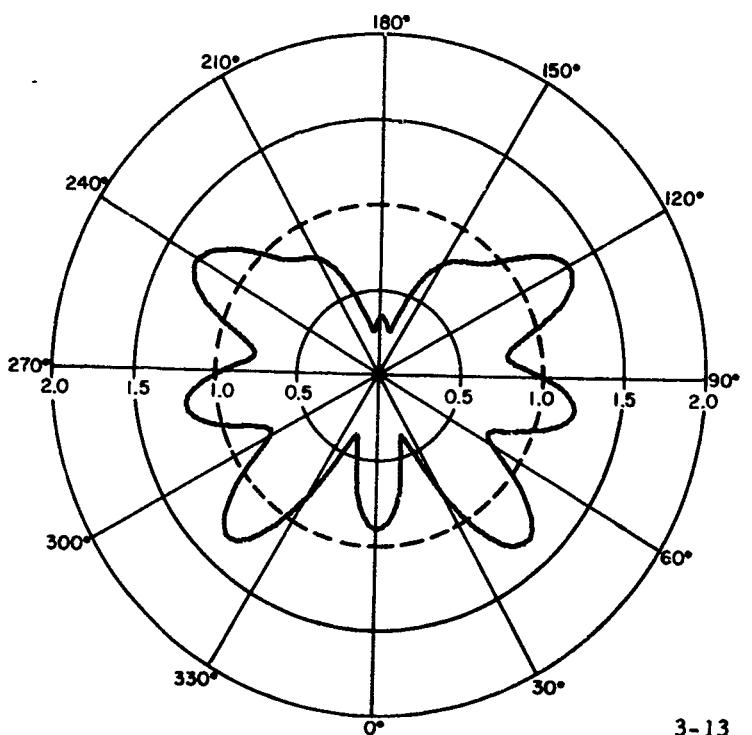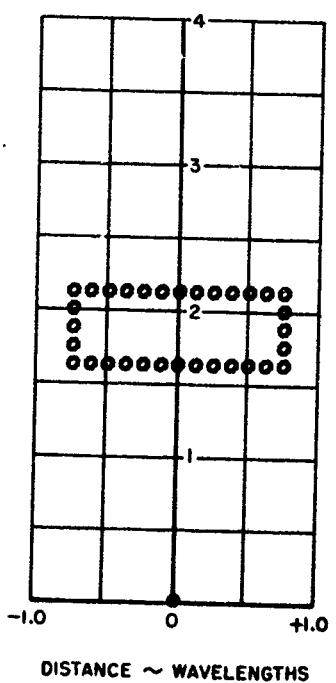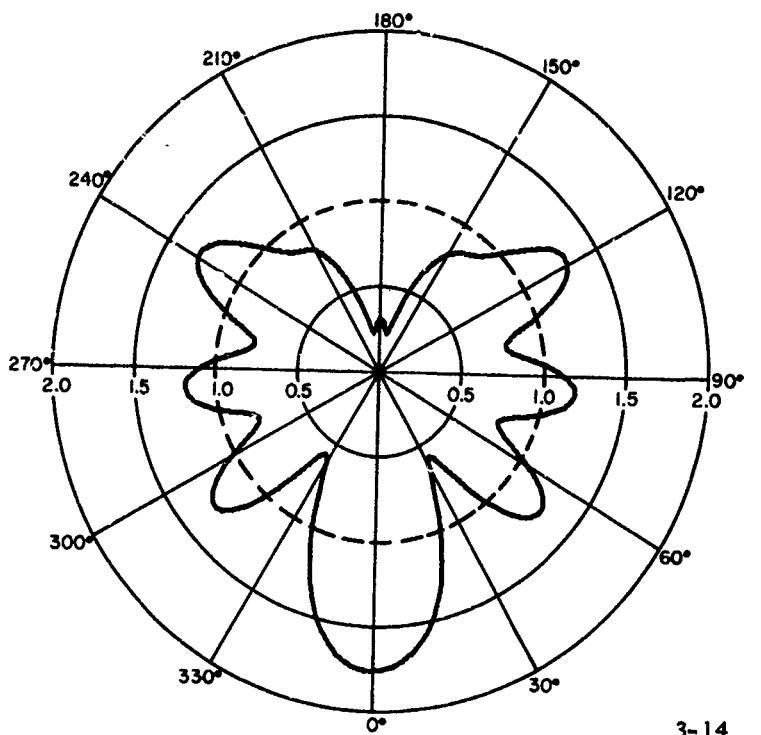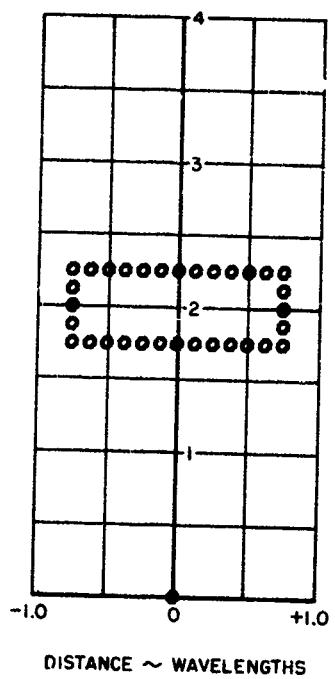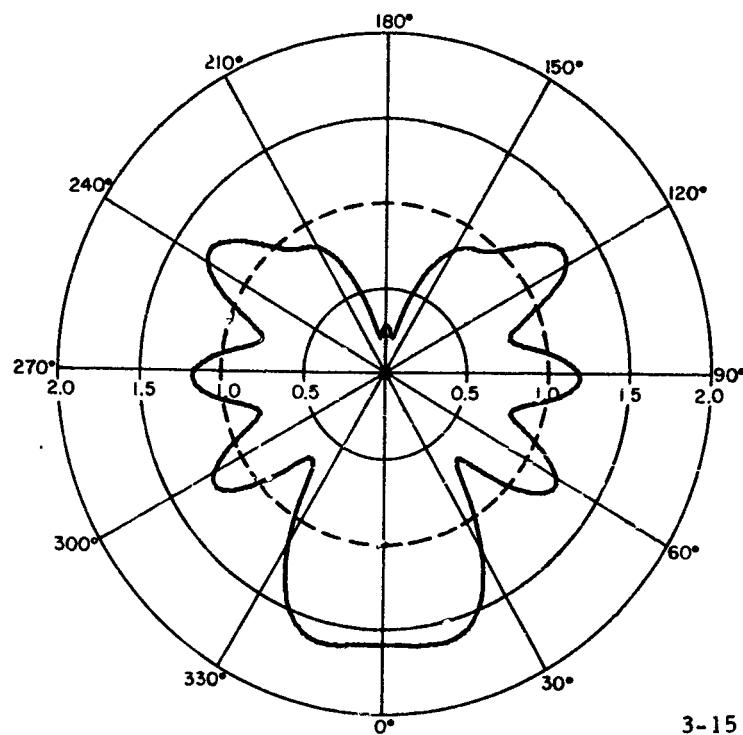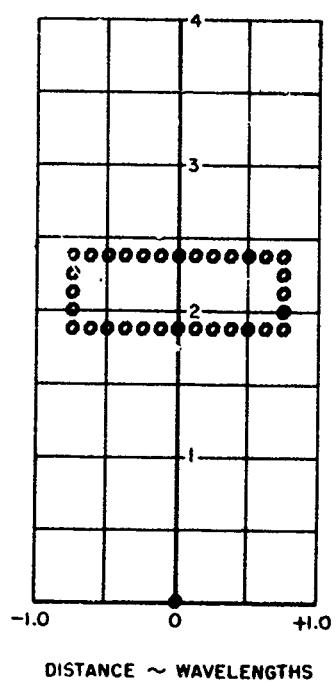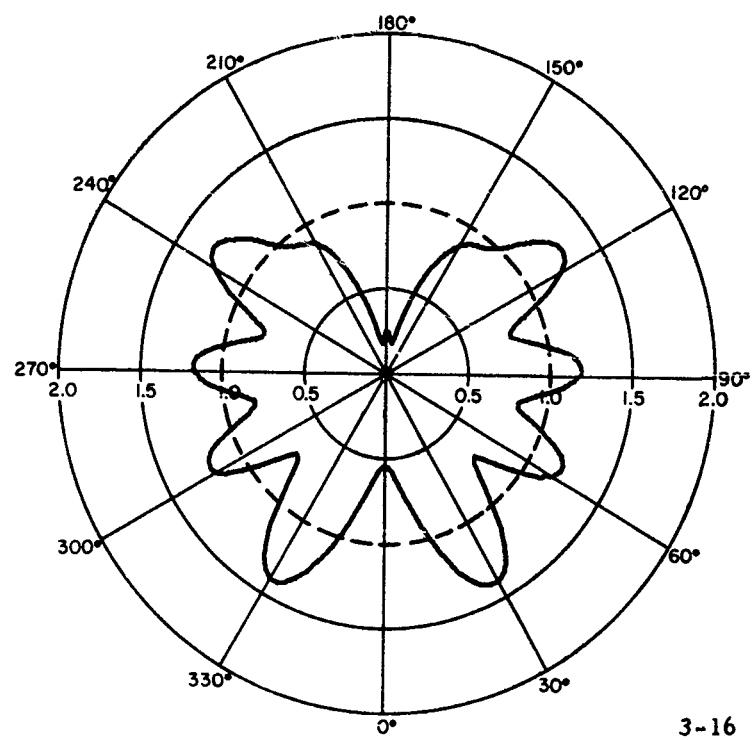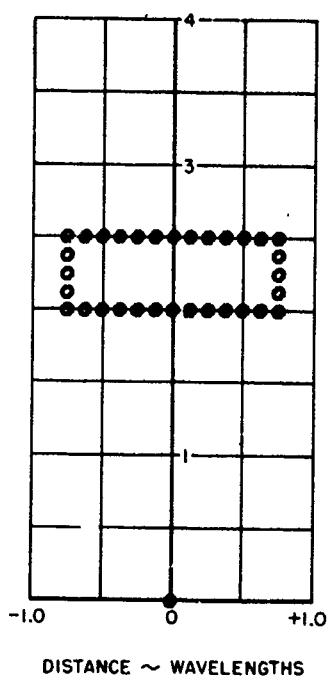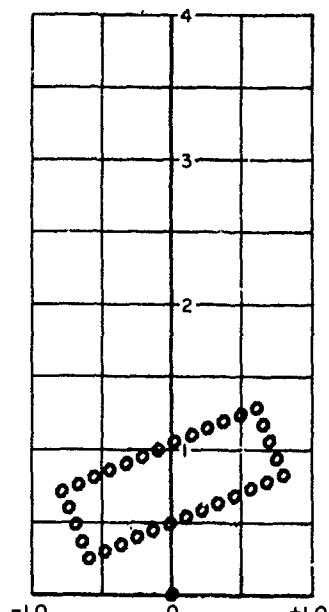
DISTANCE ~ WAVELENGTHS
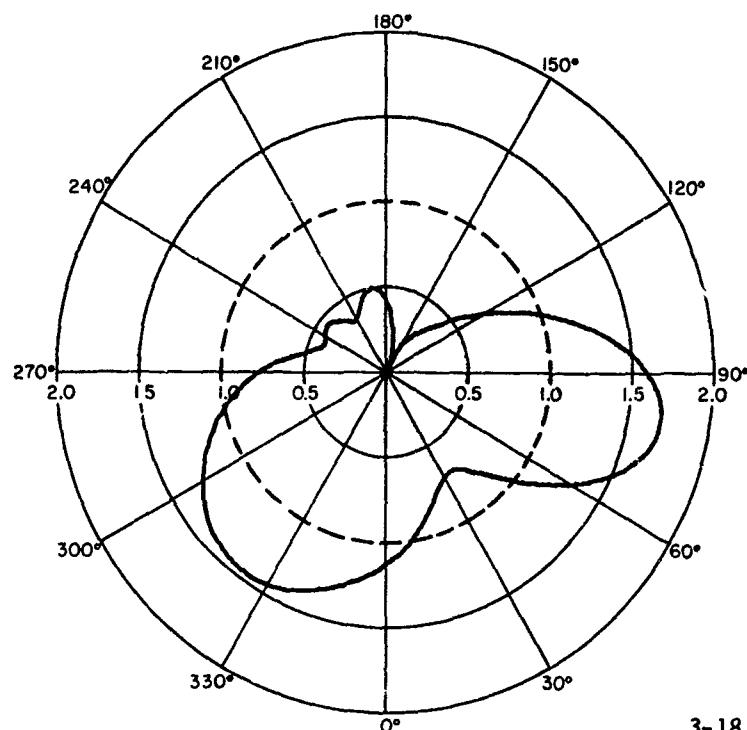
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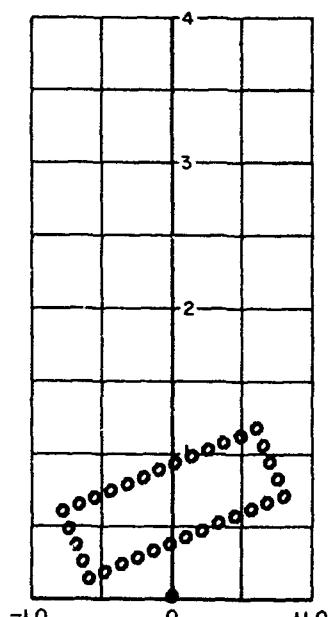
DISTANCE ~ WAVELENGTHS

3-17

89
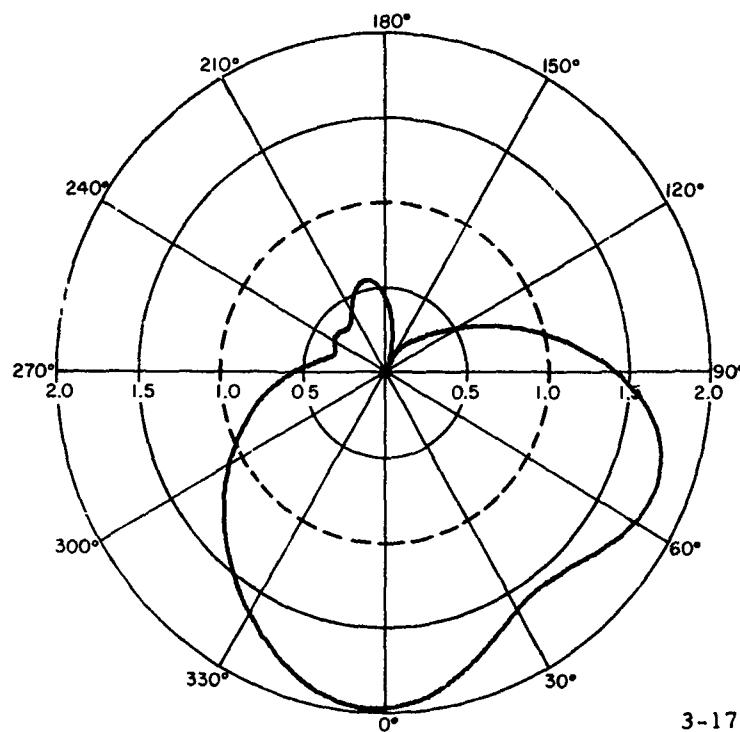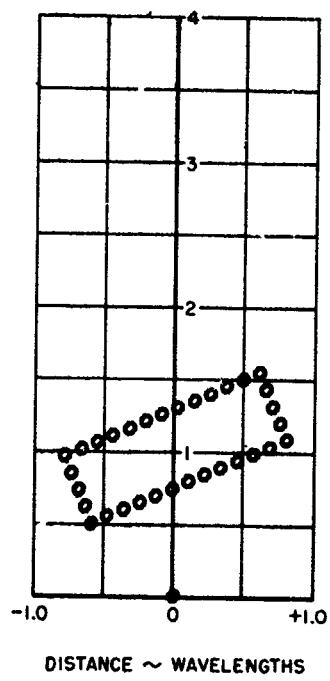
DISTANCE ~ WAVELENGTHS
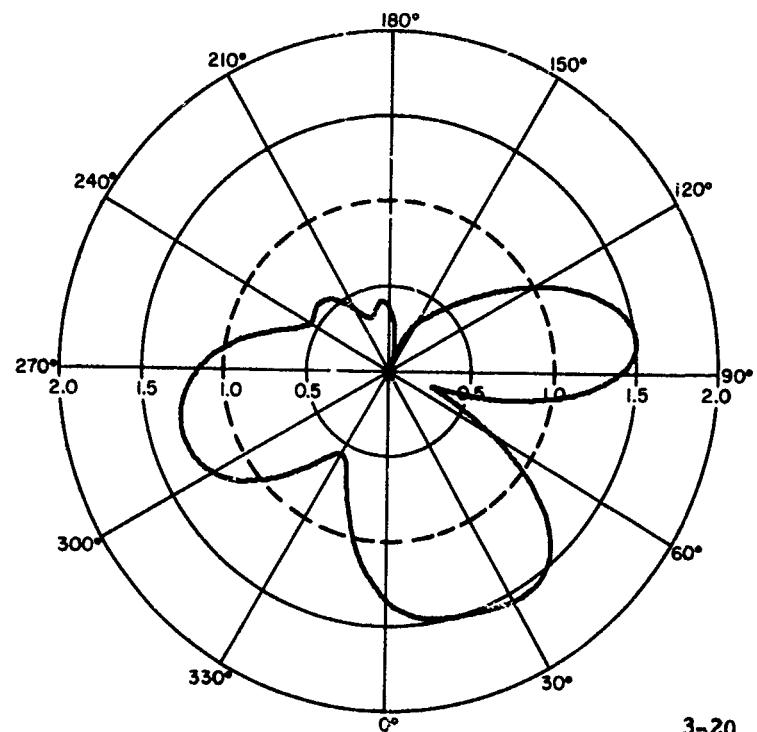
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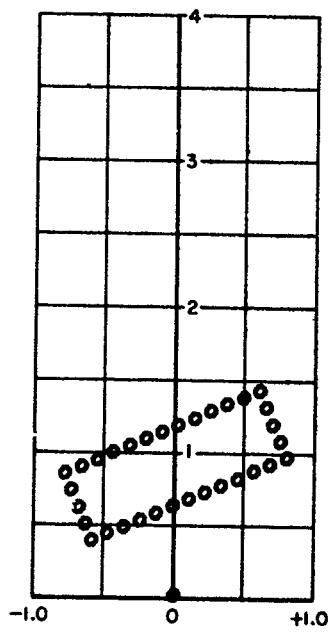
DISTANCE ~ WAVELENGTHS

3-19

90
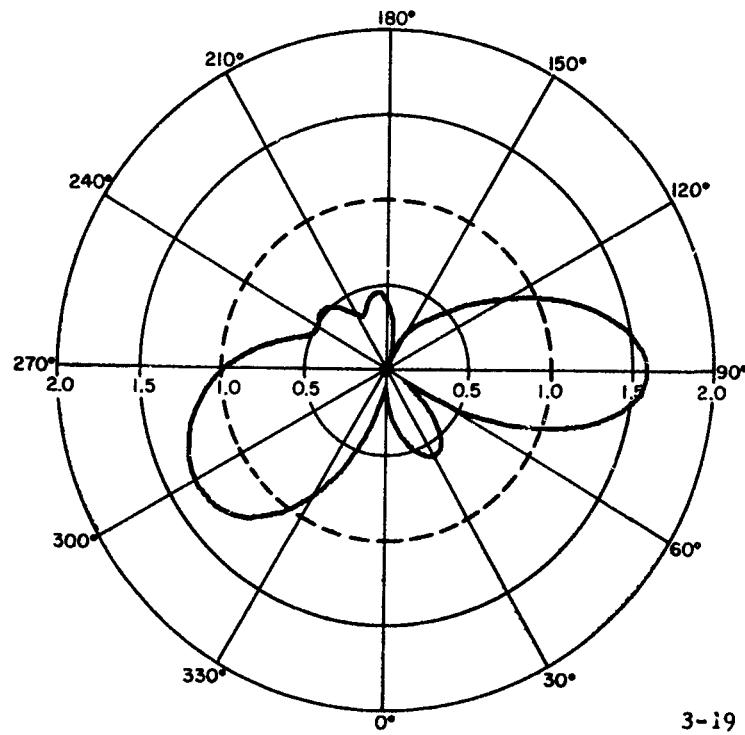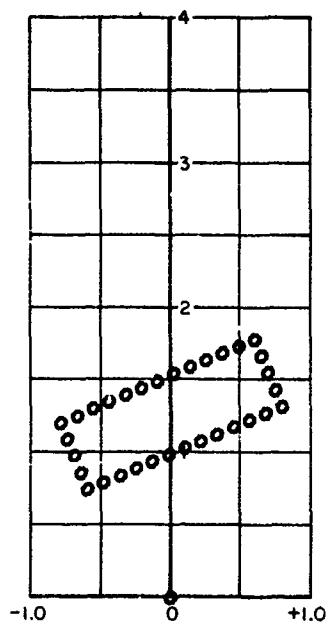
DISTANCE ∼ WAVELENGTHS

3-22

DISTANCE ∼ WAVELENGTHS

3-21

91

DISTANCE ~ WAVELENGTHS

3-24

DISTANCE ~ WAVELENGTHS

3-23

92
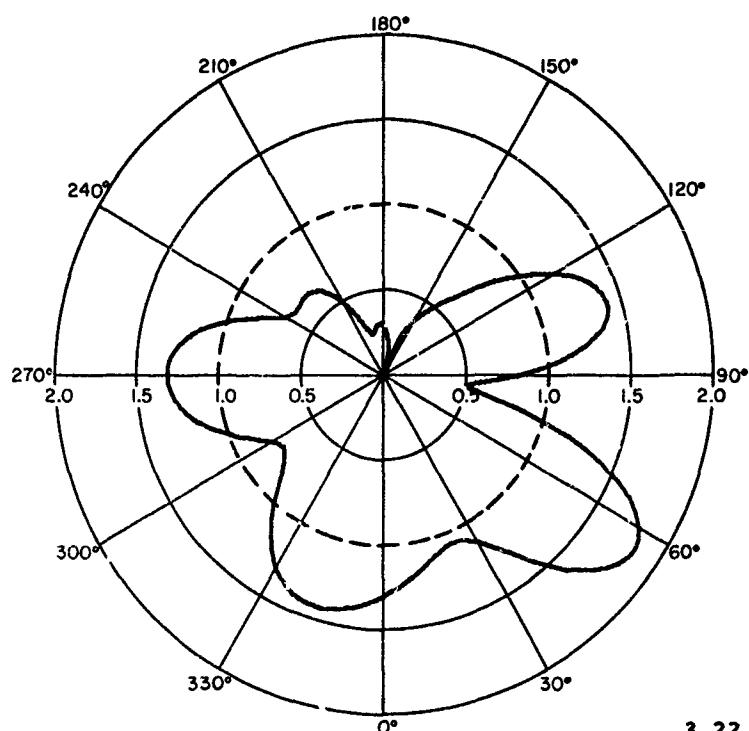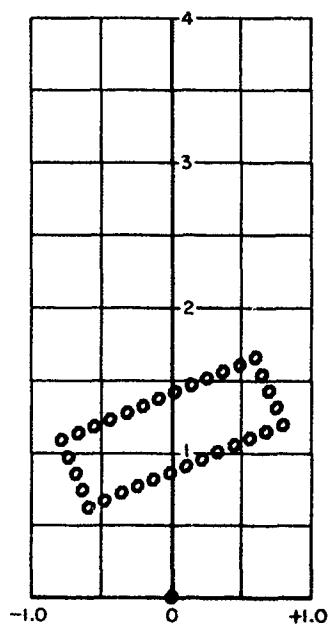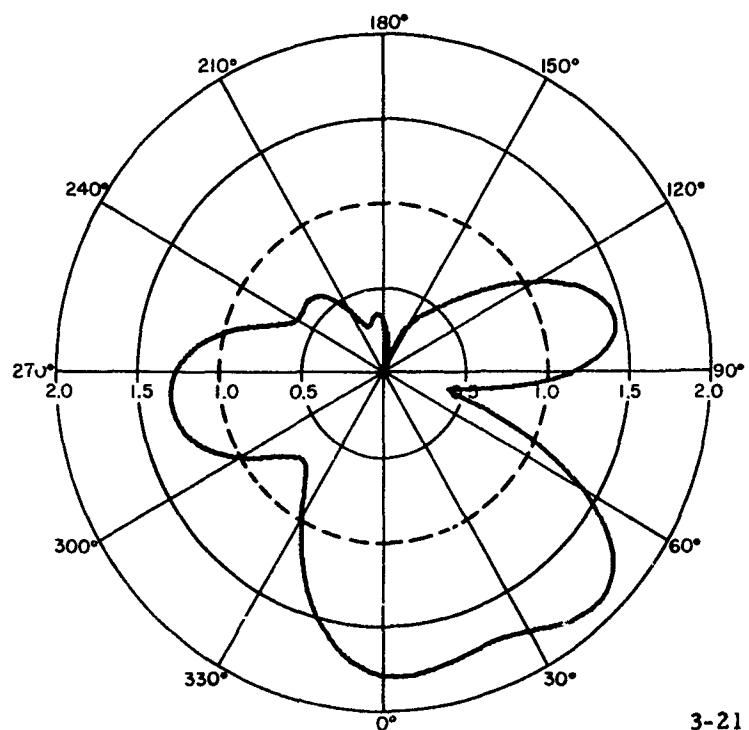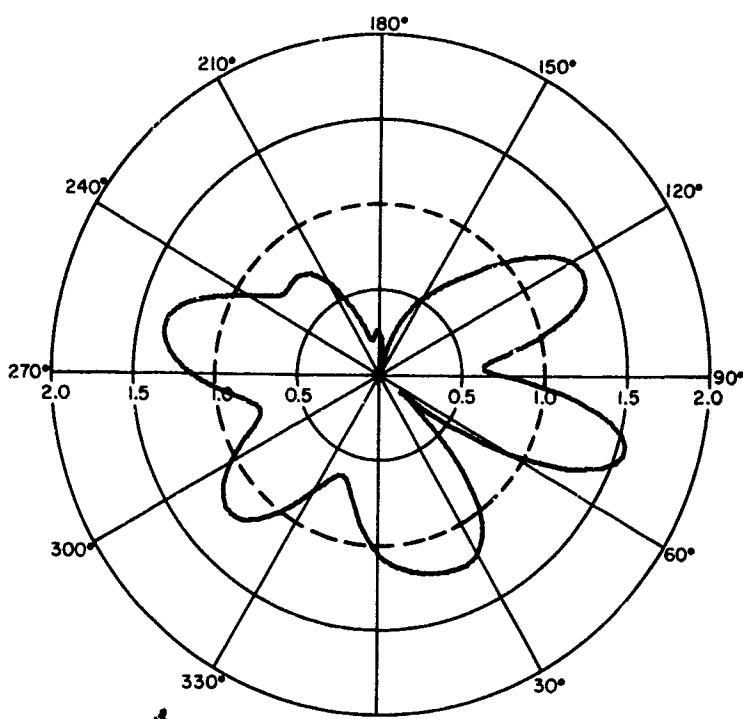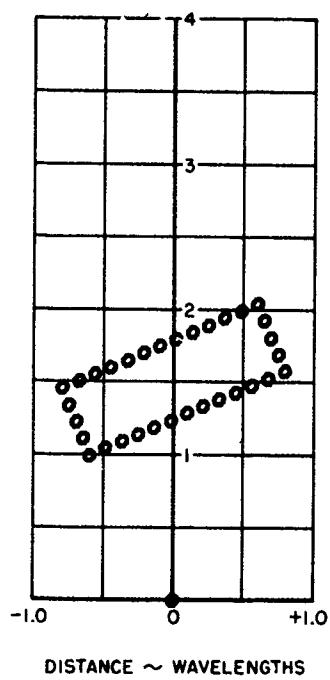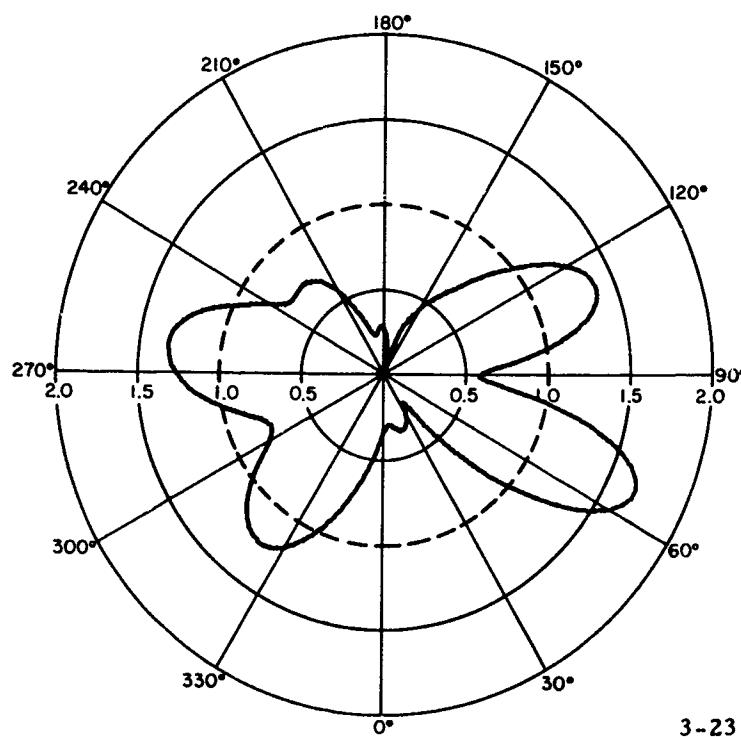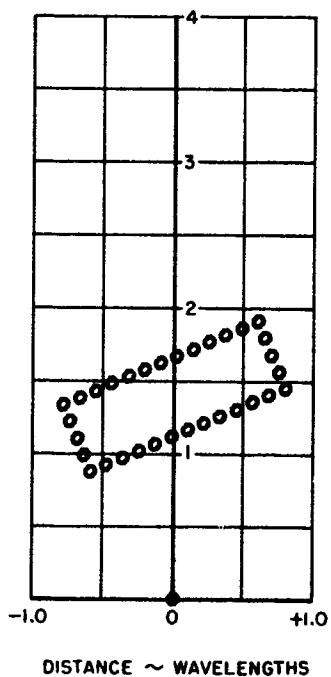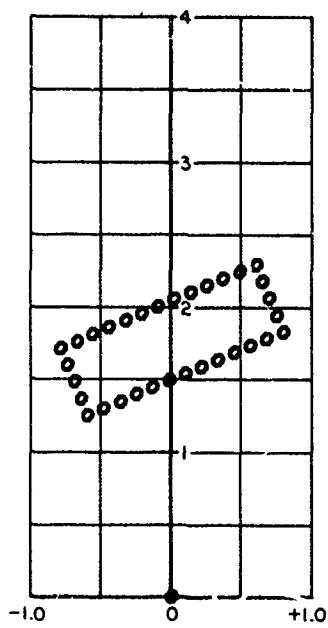
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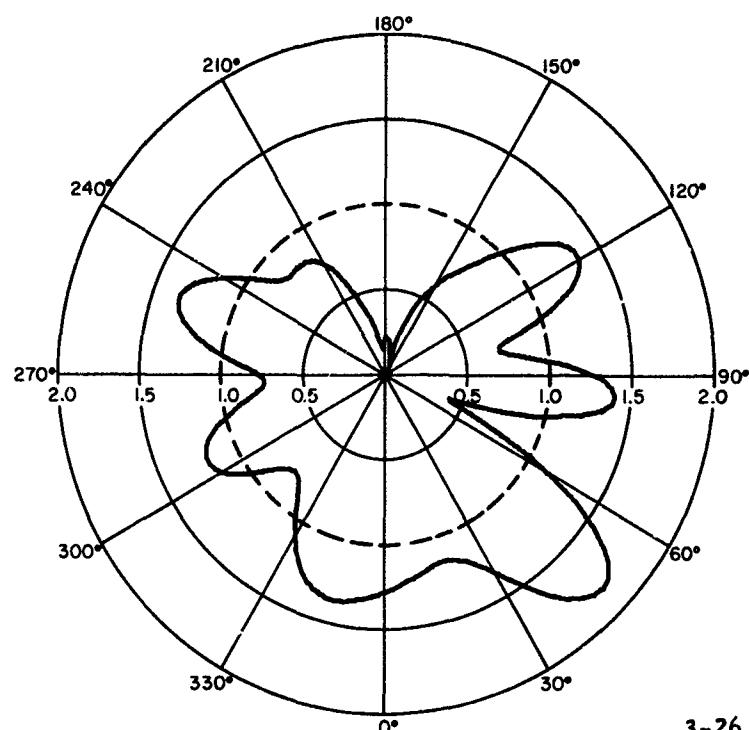
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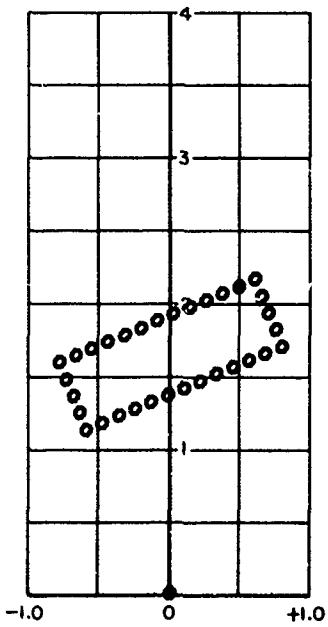
DISTANCE ~ WAVELENGTHS

3-25

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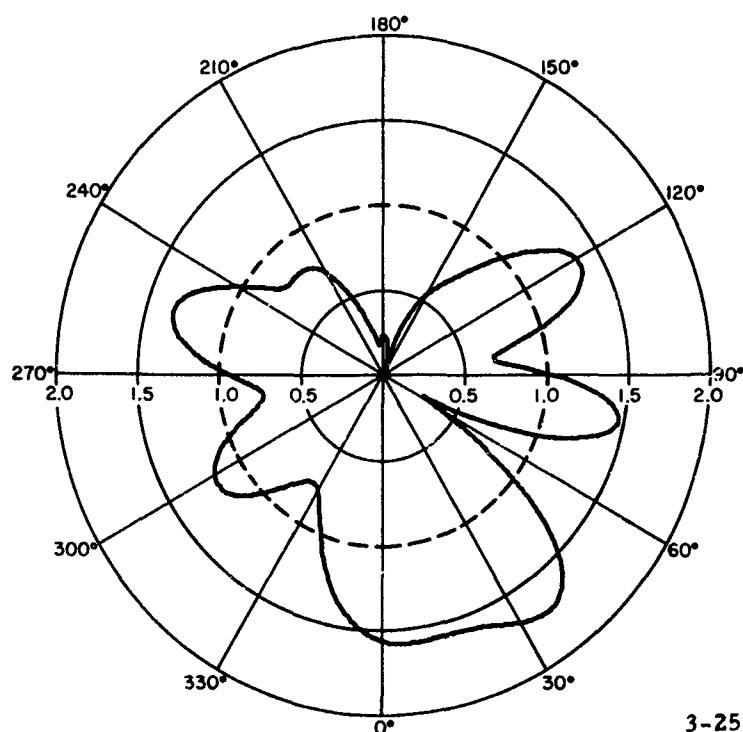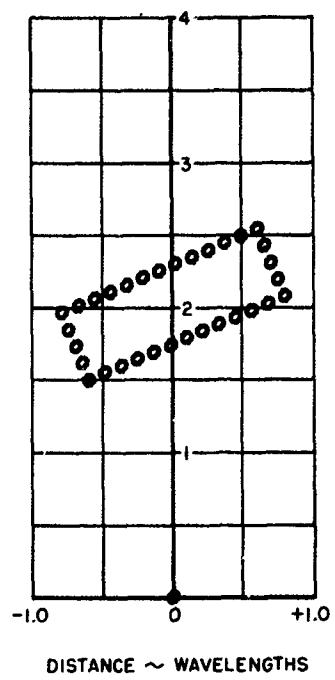
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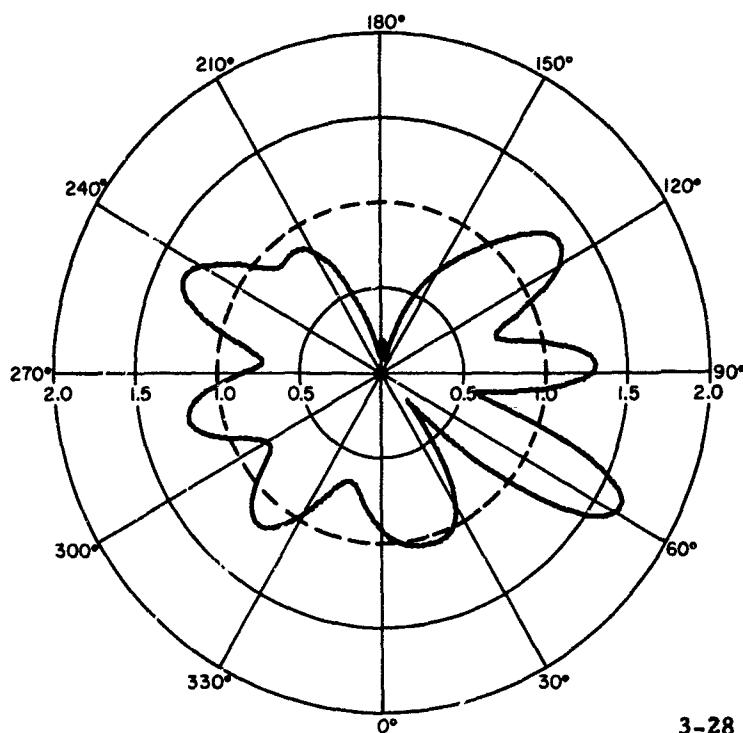
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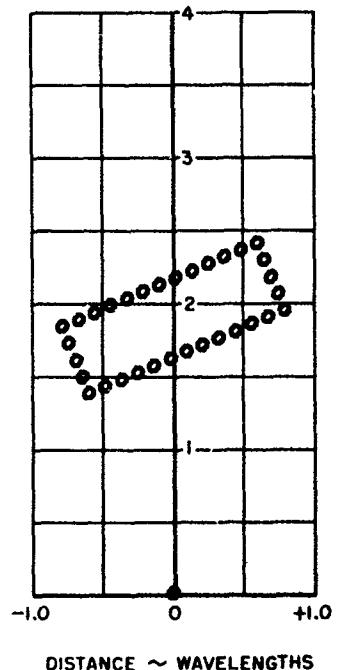
DISTANCE ~ WAVELENGTHS

3-27

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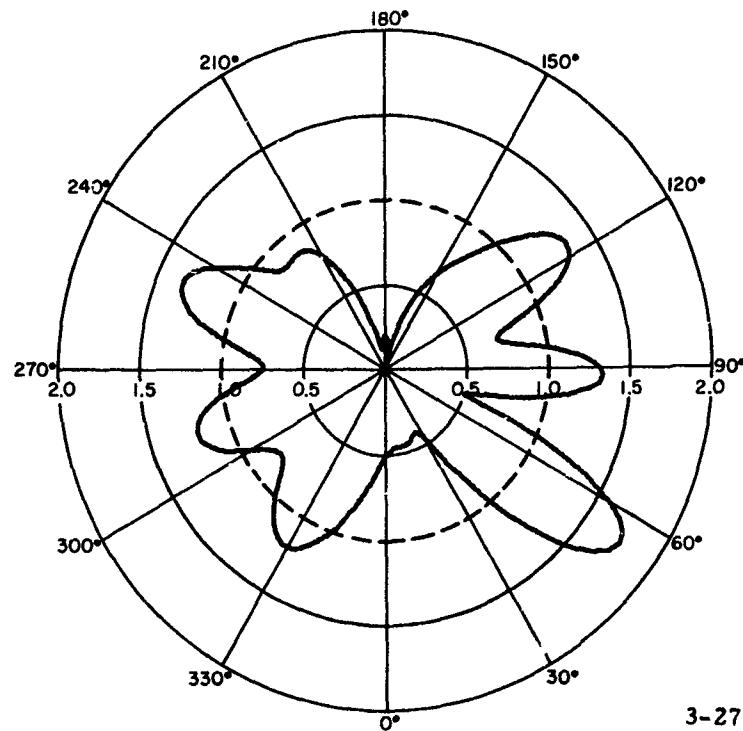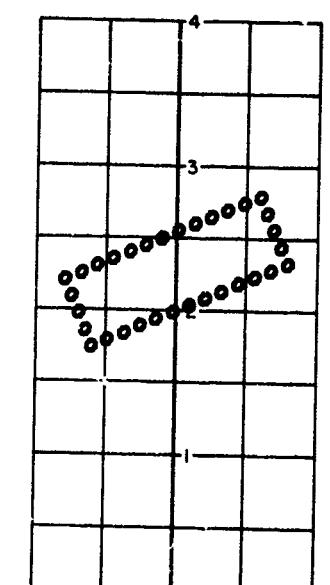
DISTANCE ~ WAVELENGTHS

3-30

DISTANCE ~ WAVELENGTHS

3-29

95

DISTANCE ∼ WAVELENGTHS

3-32

DISTANCE ∼ WAVELENGTHS

3-31

96

DISTANCE ~ WAVELENGTHS

3-34

DISTANCE ~ WAVELENGTHS

3-35

97

DISTANCE ~ WAVELENGTHS

3-36

DISTANCE ~ WAVELENGTHS

3-35

98
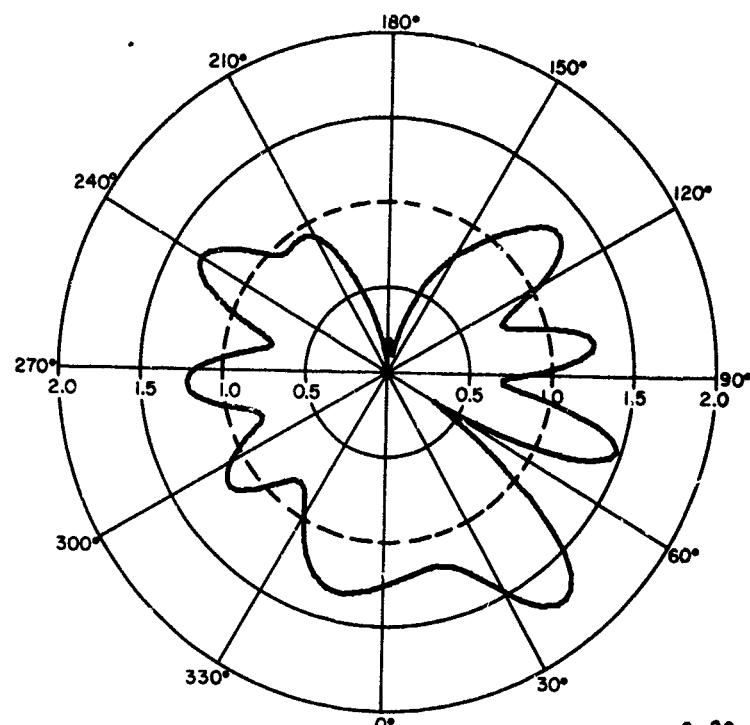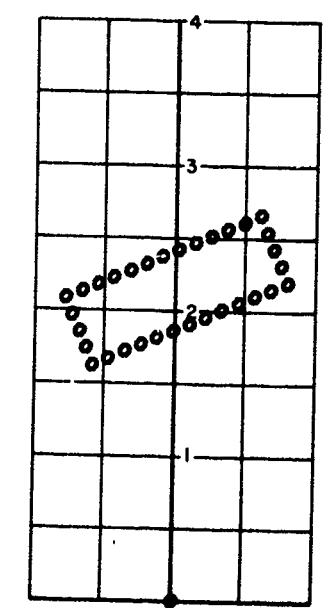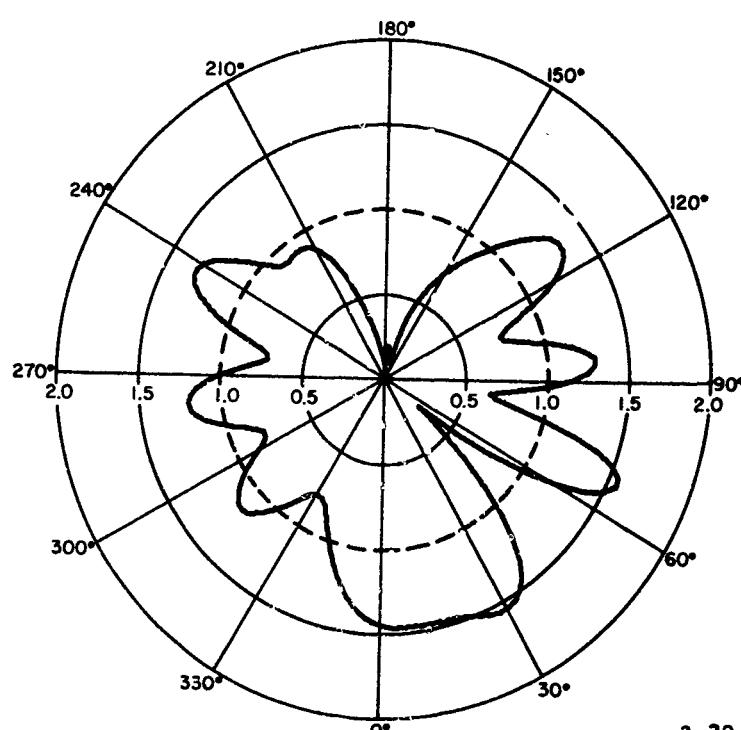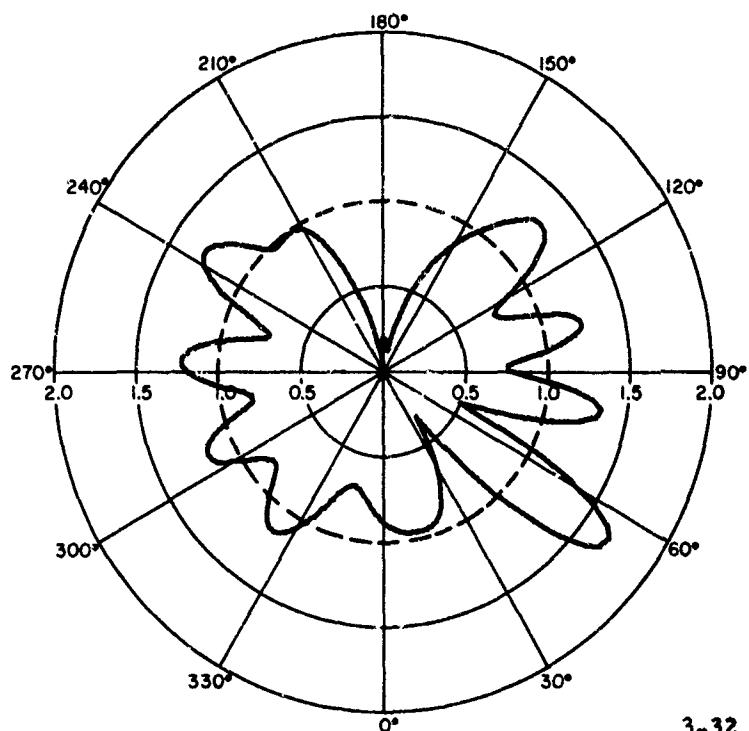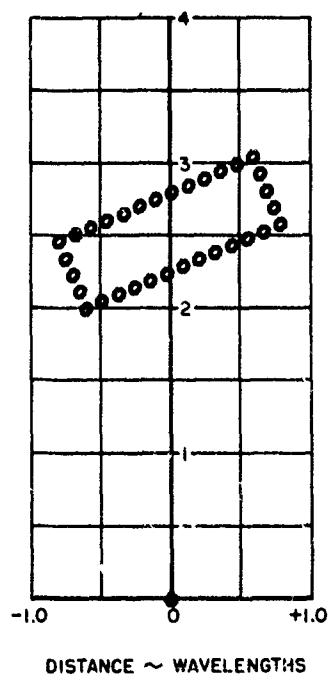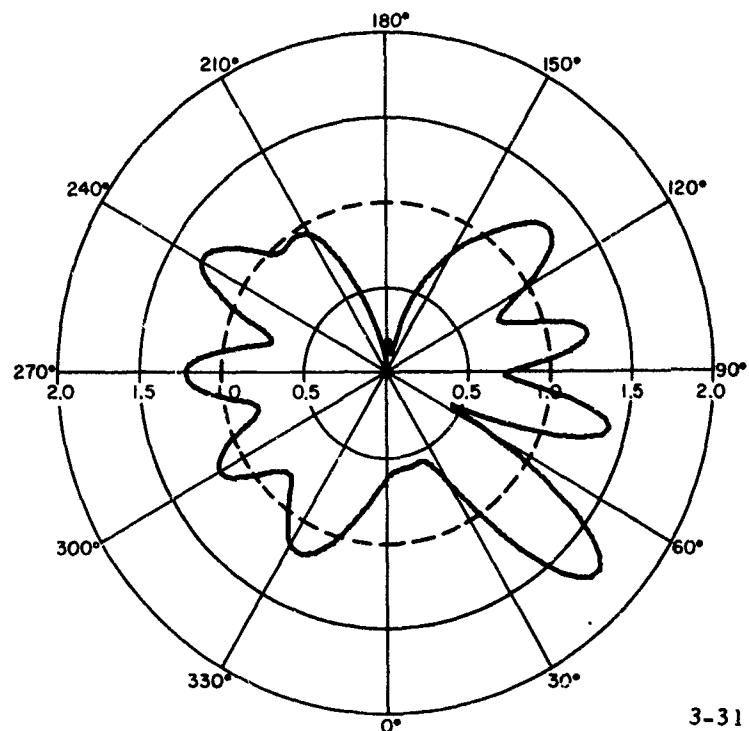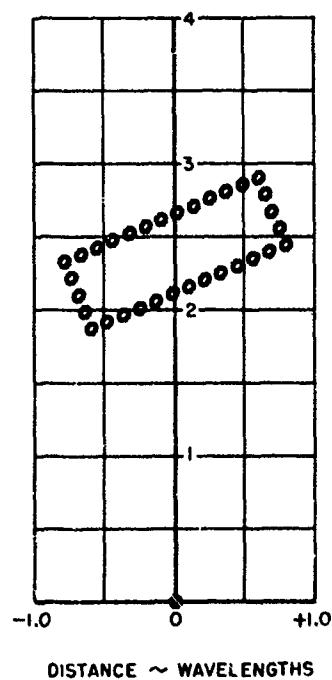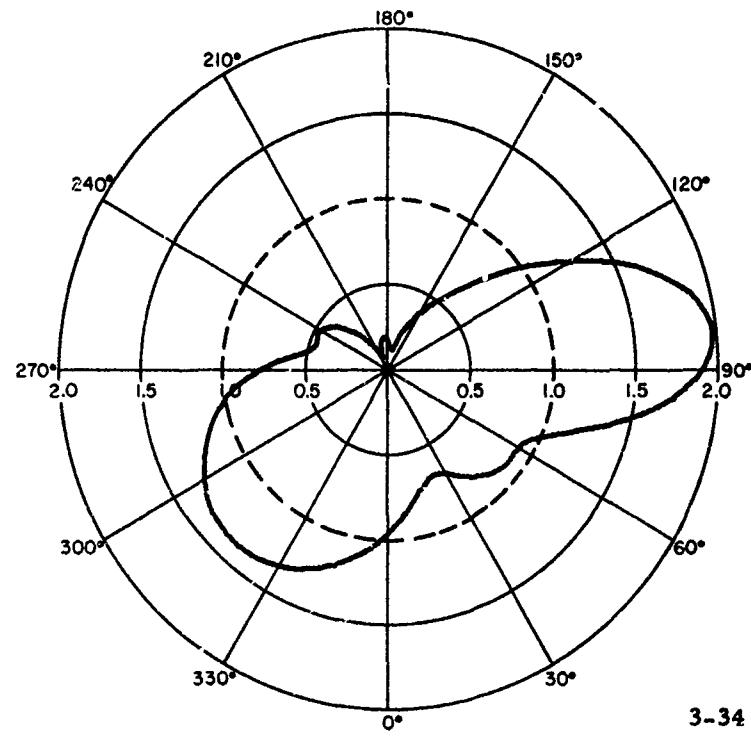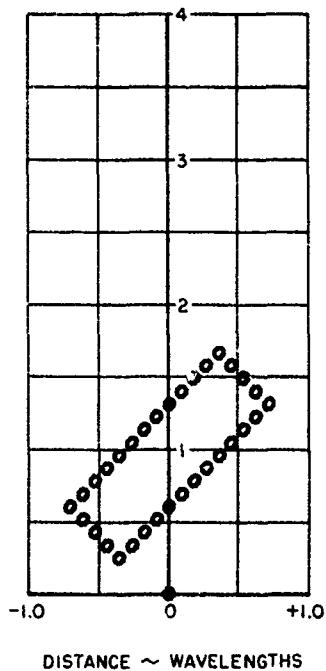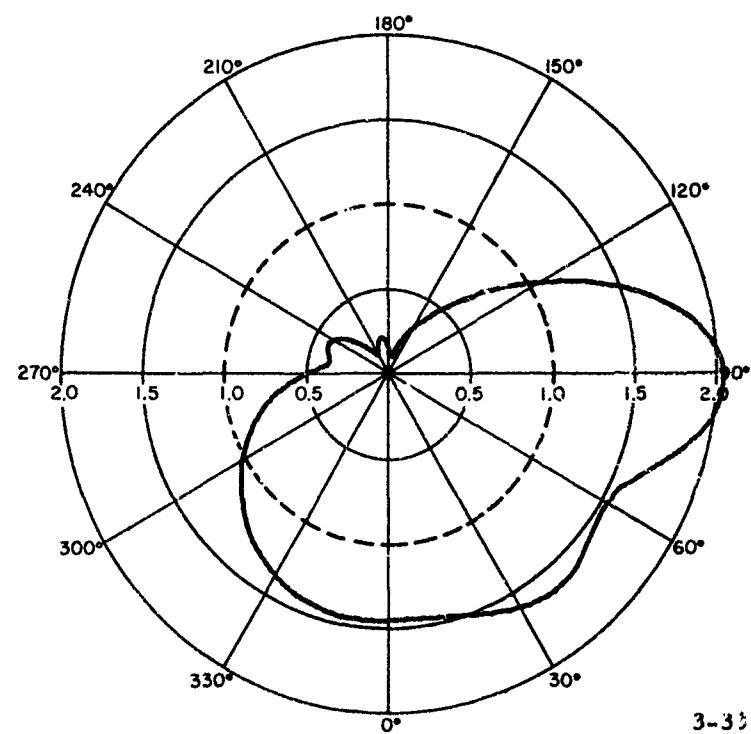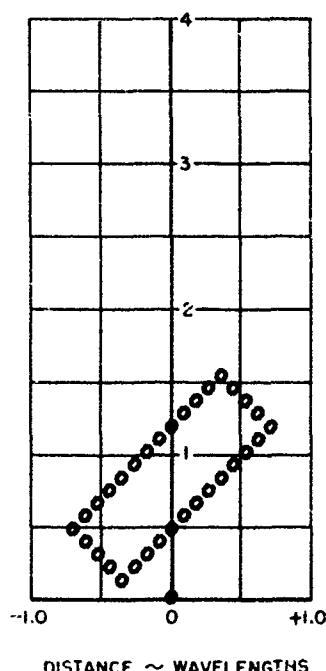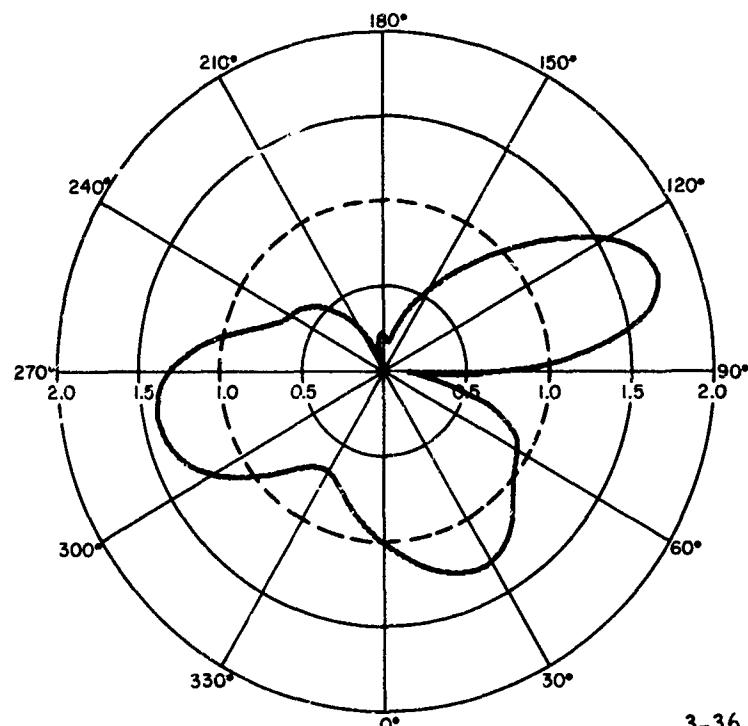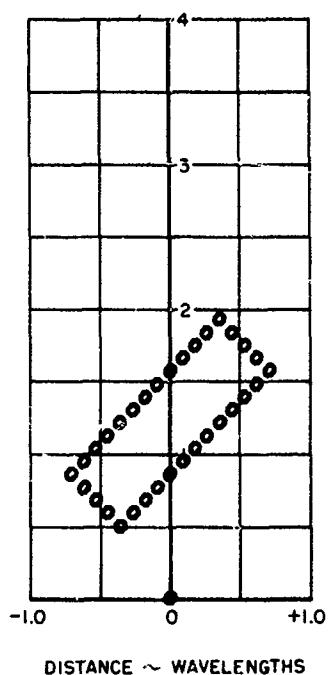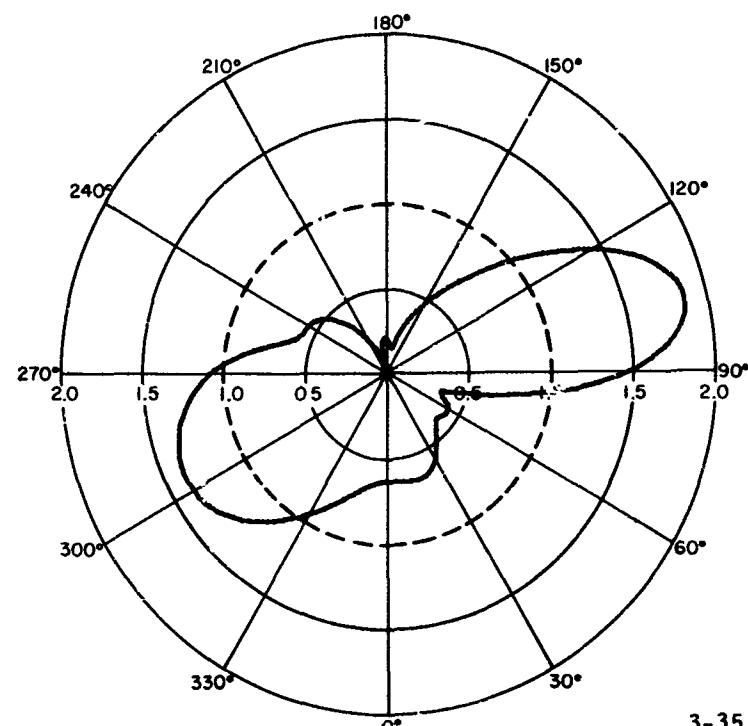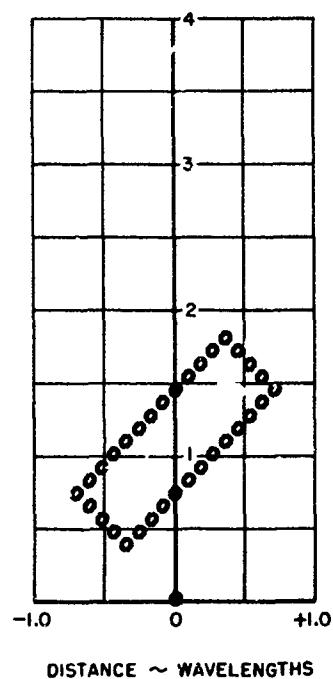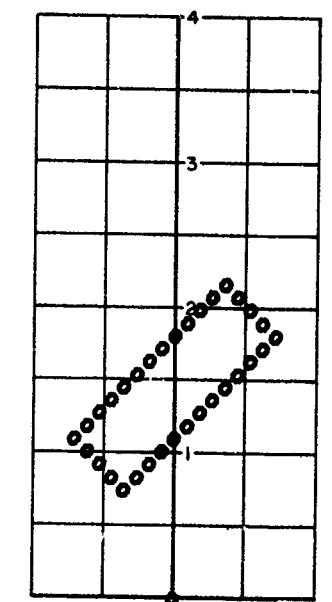
DISTANCE ~ WAVELENGTHS

3-38

DISTANCE ~ WAVELENGTHS

3-37

99

DISTANCE ~ WAVELENGTHS

3-40

DISTANCE ~ WAVELENGTHS

3-39

100
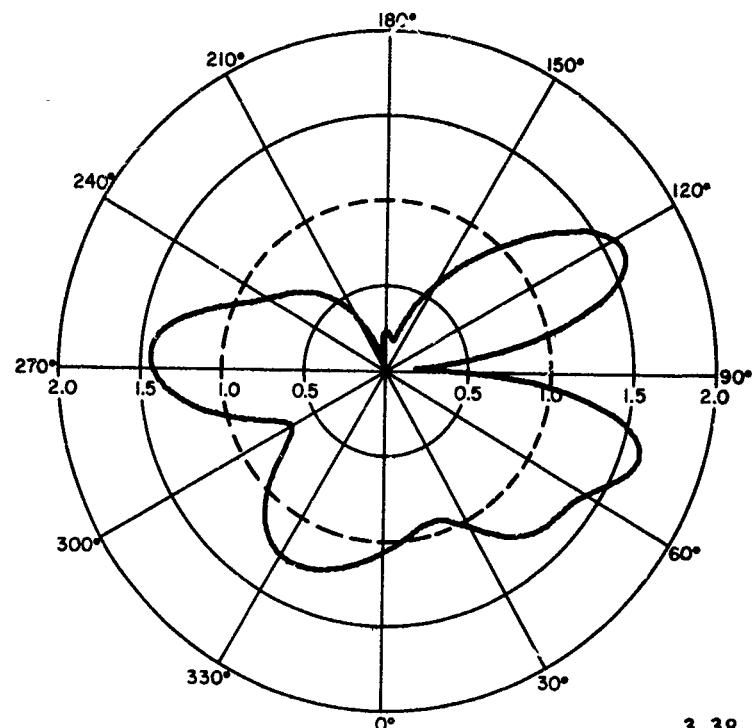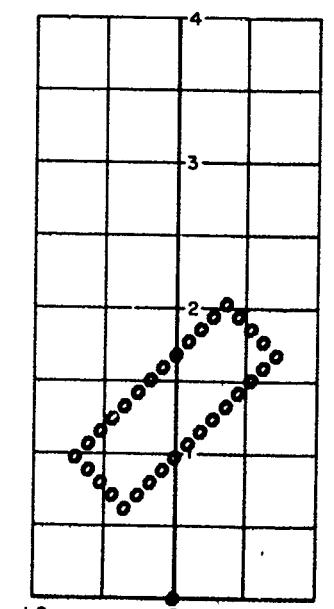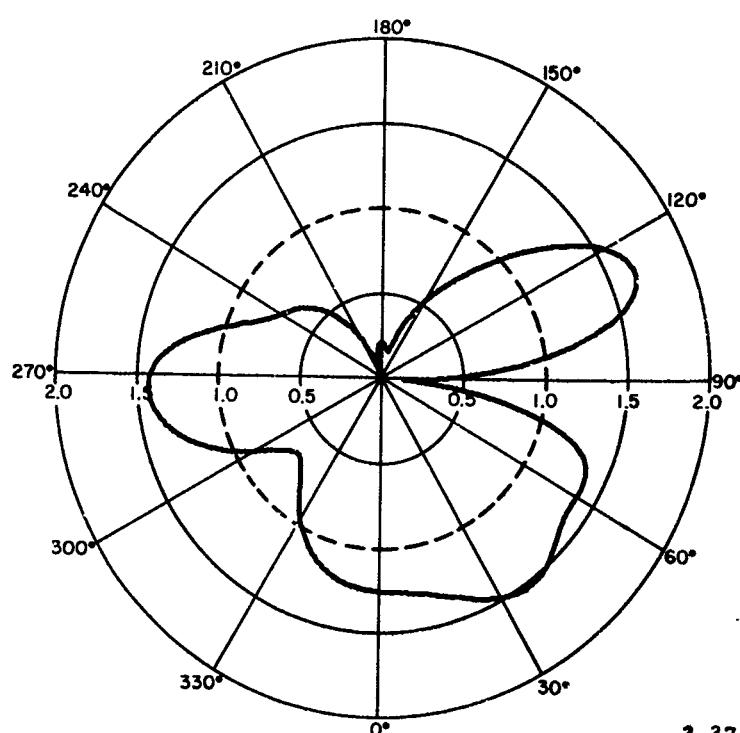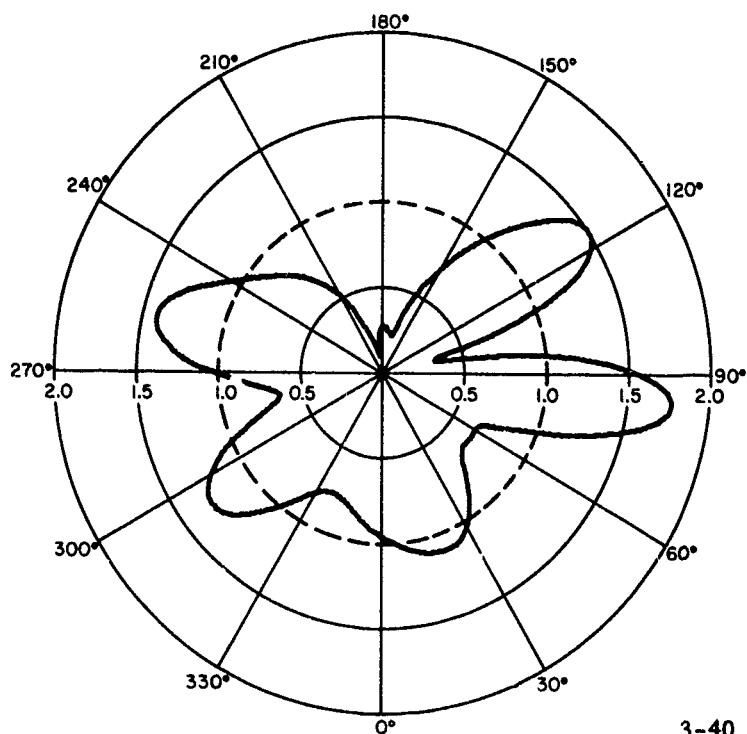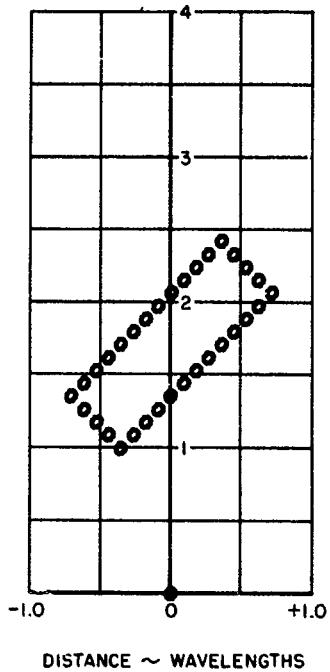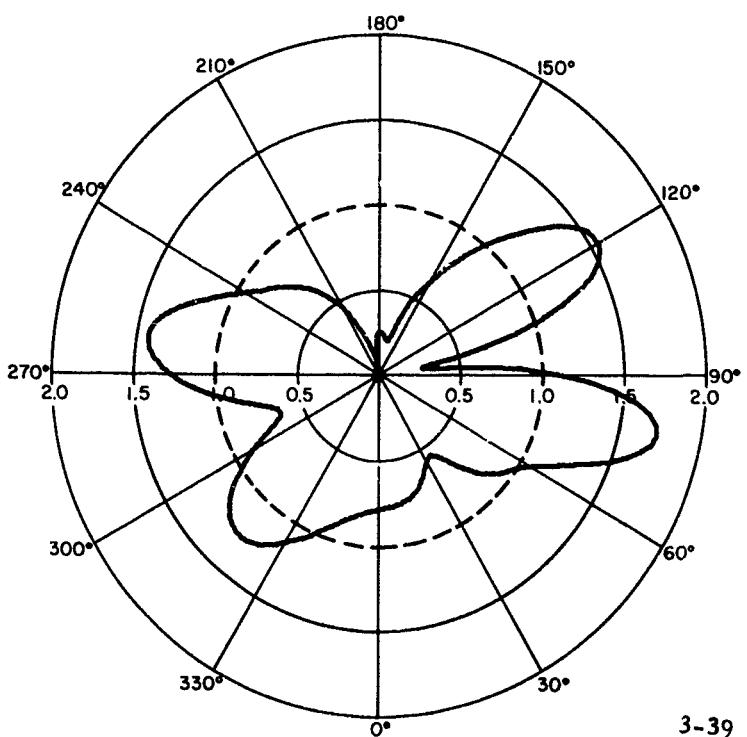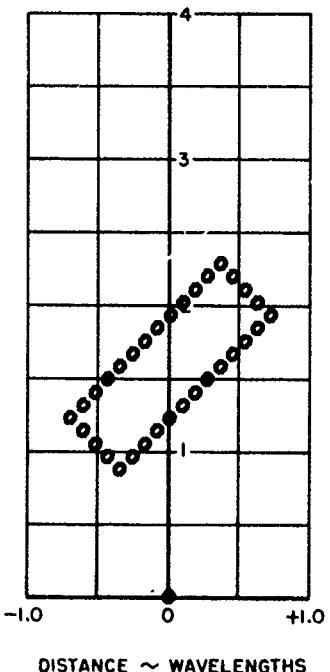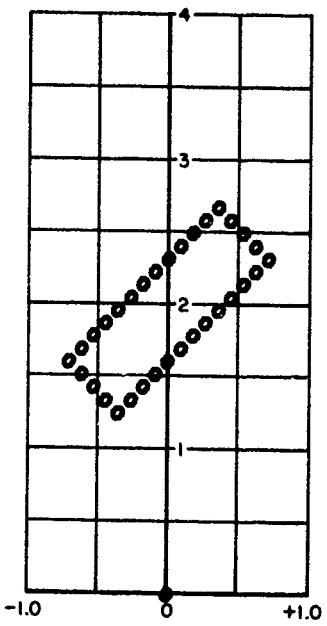
DISTANCE ~ WAVELENGTHS

3-42
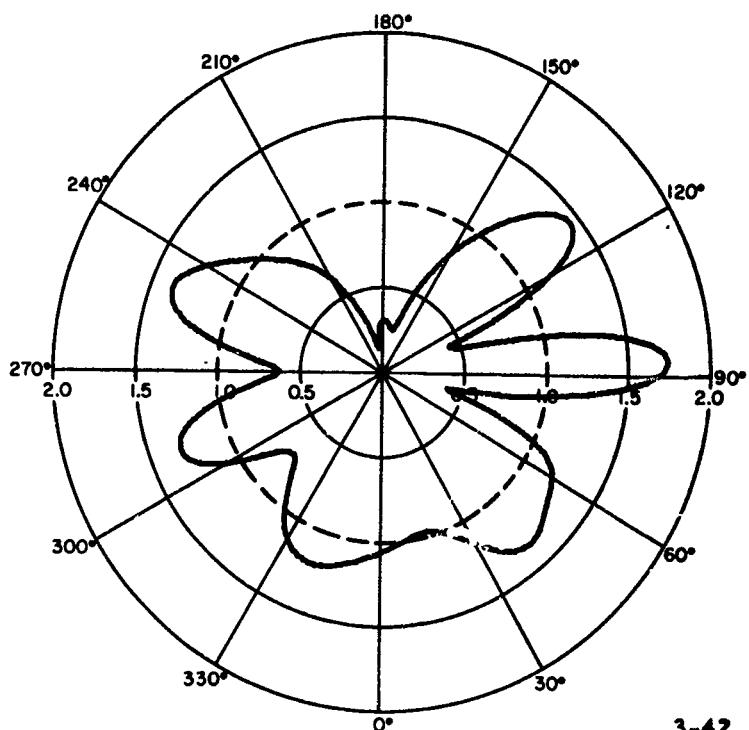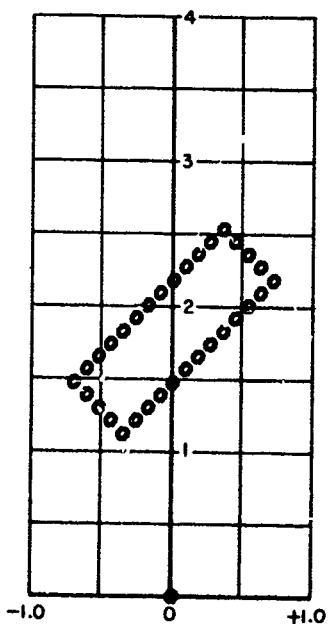
DISTANCE ~ WAVELENGTHS

3-41

101
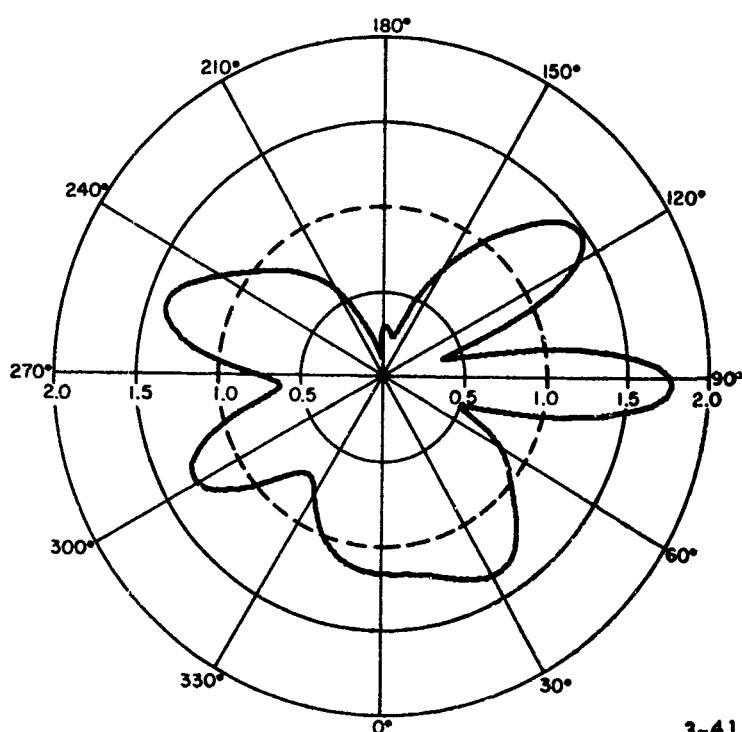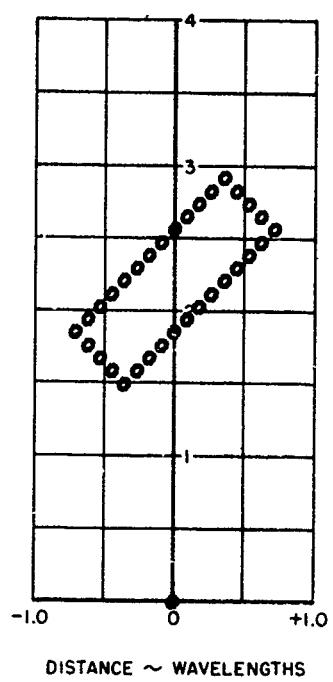
DISTANCE ~ WAVELENGTHS
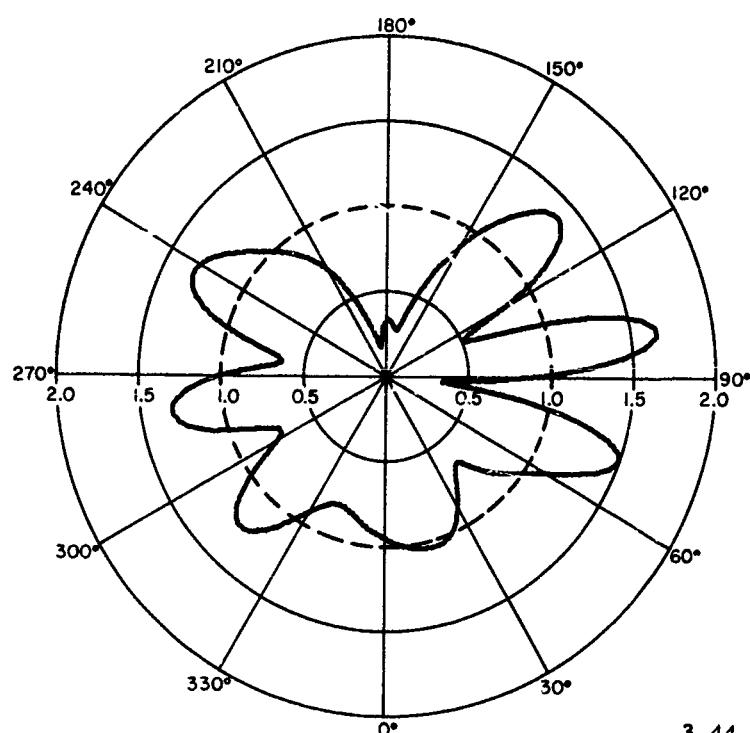
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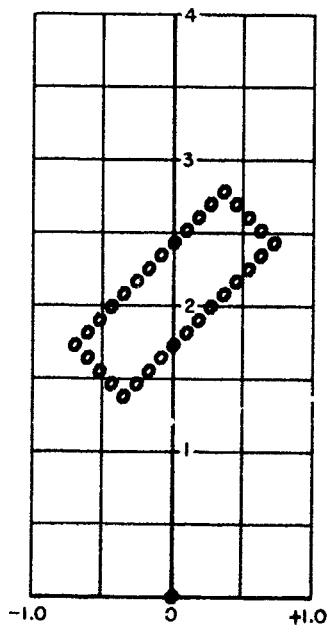
DISTANCE ~ WAVELENGTHS

3-43

102
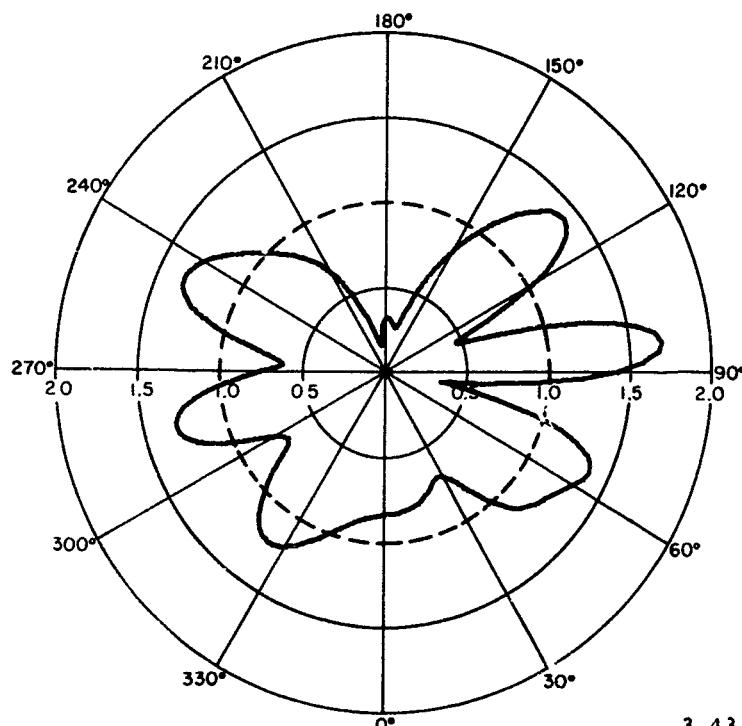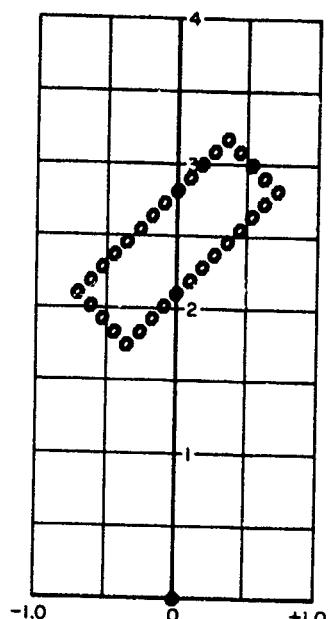
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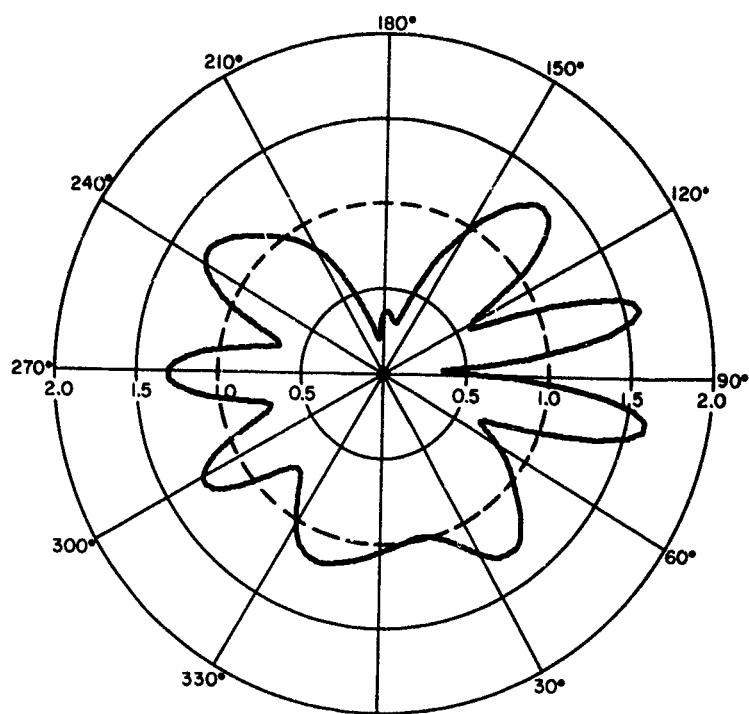
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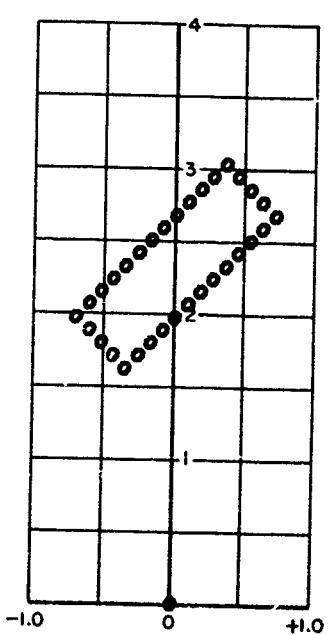
DISTANCE ~ WAVELENGTHS

3-45

103
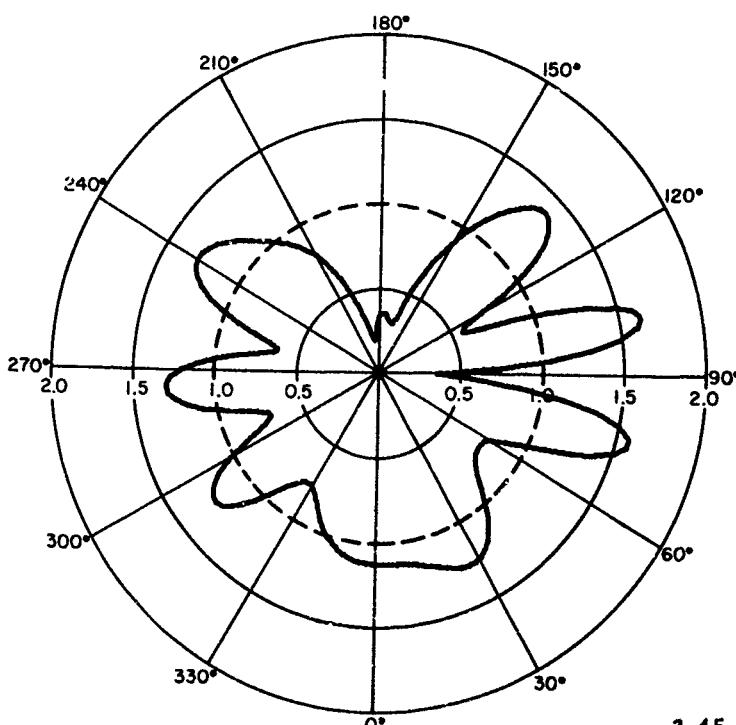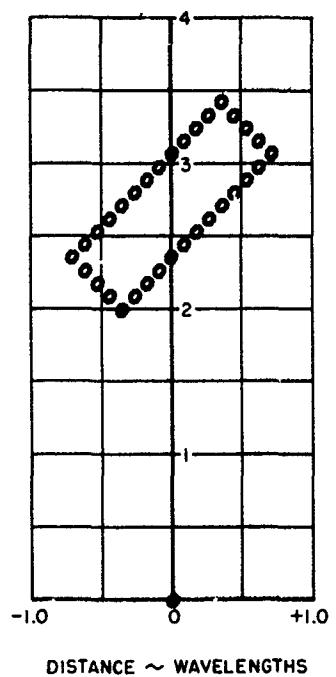
DISTANCE ~ WAVELENGTHS

3-48

DISTANCE ~ WAVELENGTHS

3-47

104

DISTANCE ~ WAVELENGTHS

3-50

DISTANCE ~ WAVELENGTHS

3-49

105

DISTANCE ~ WAVELENGTHS

3-52

DISTANCE ~ WAVELENGTHS

3-51

106

DISTANCE ~ WAVELENGTHS

3-54

DISTANCE ~ WAVELENGTHS

3-53

107
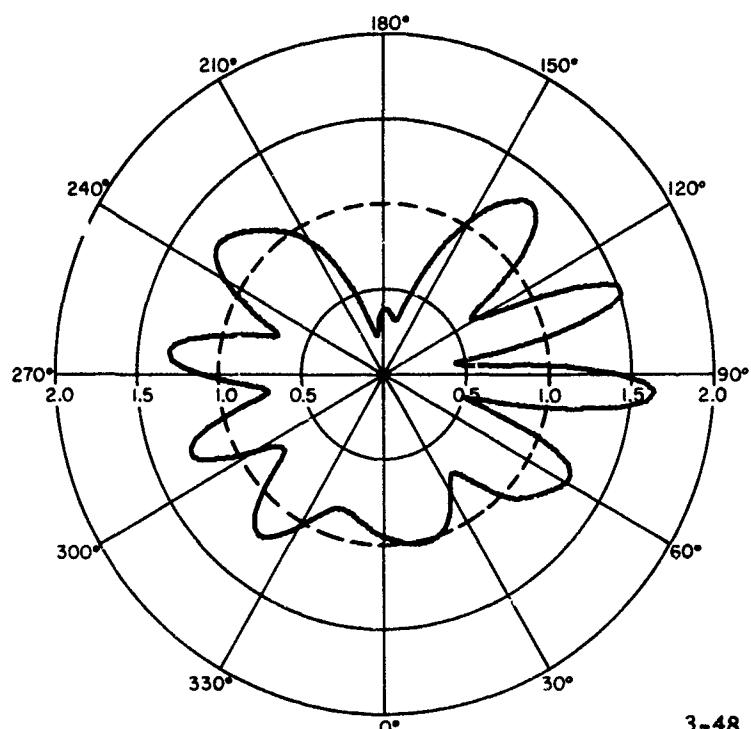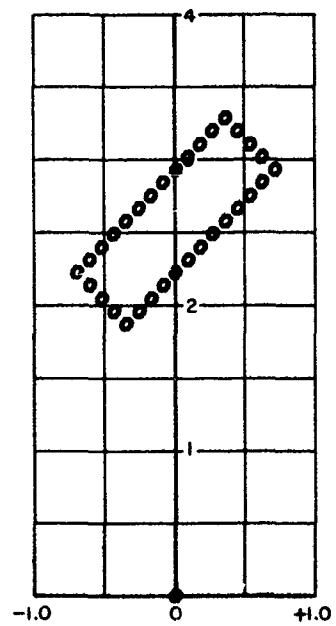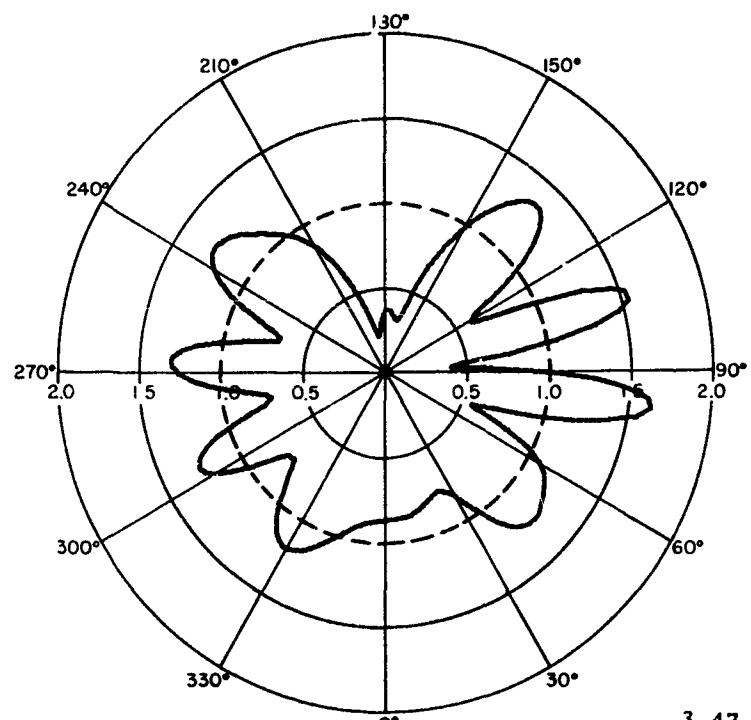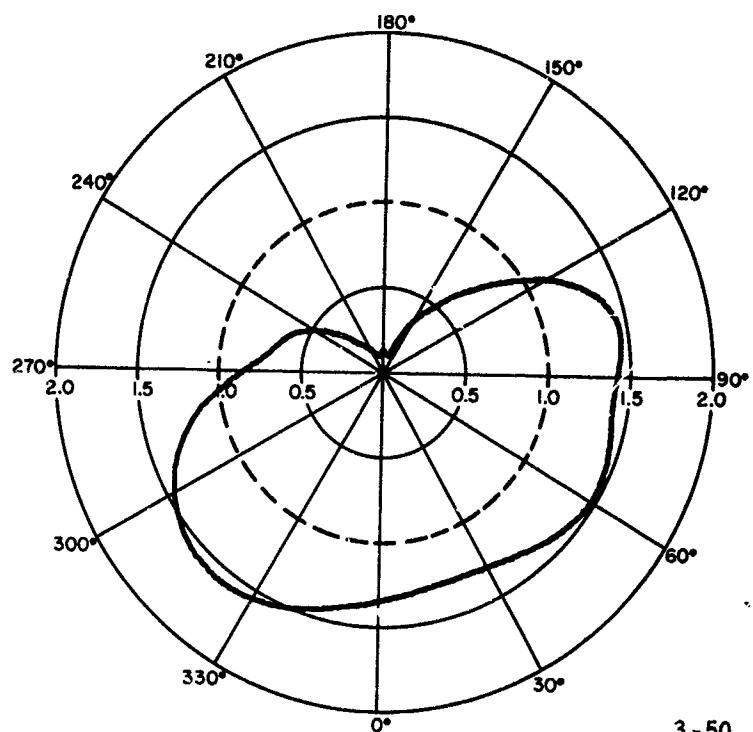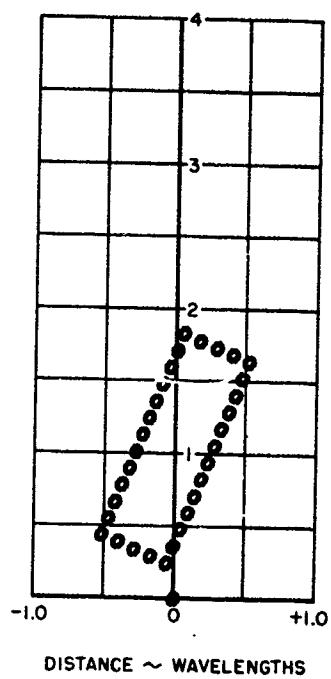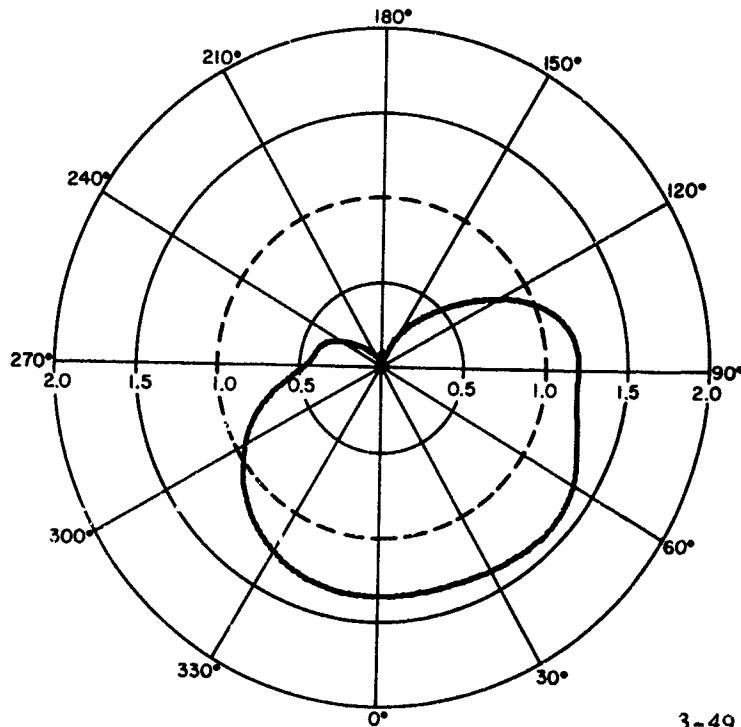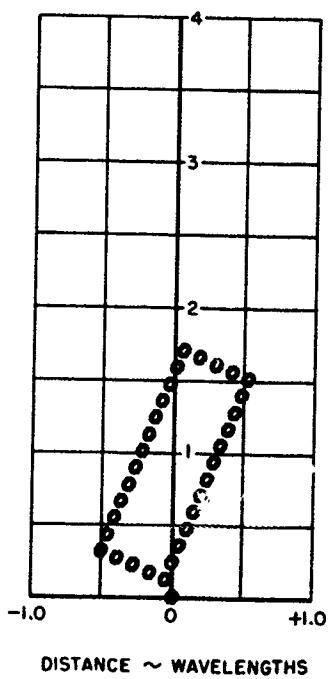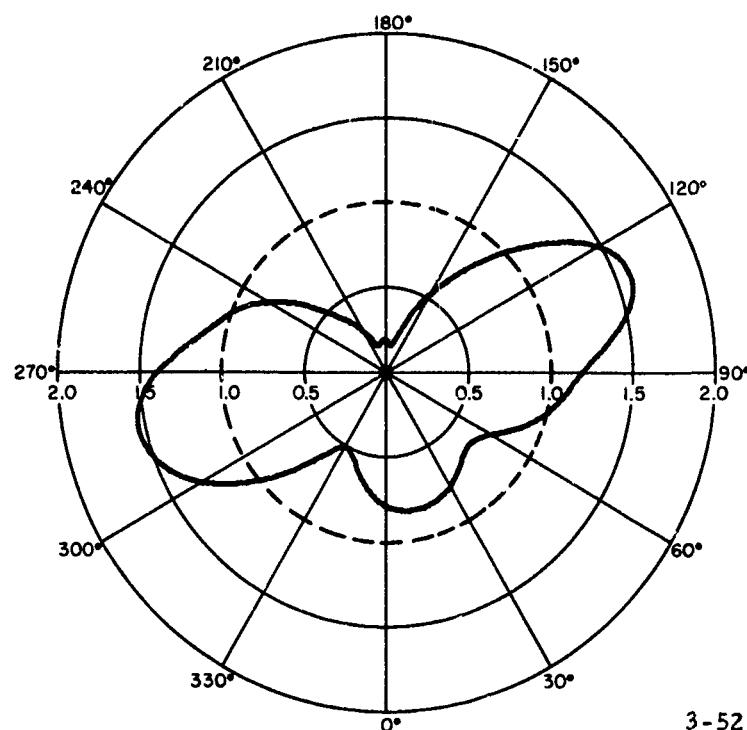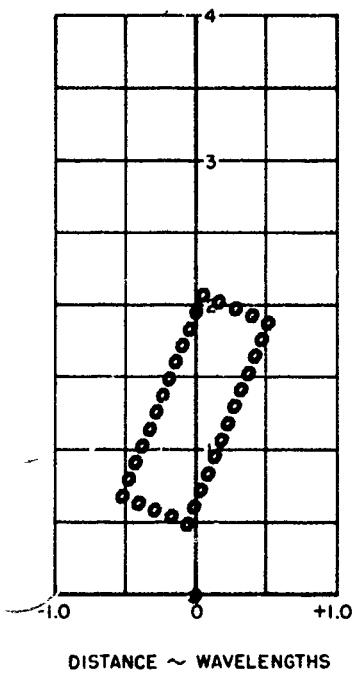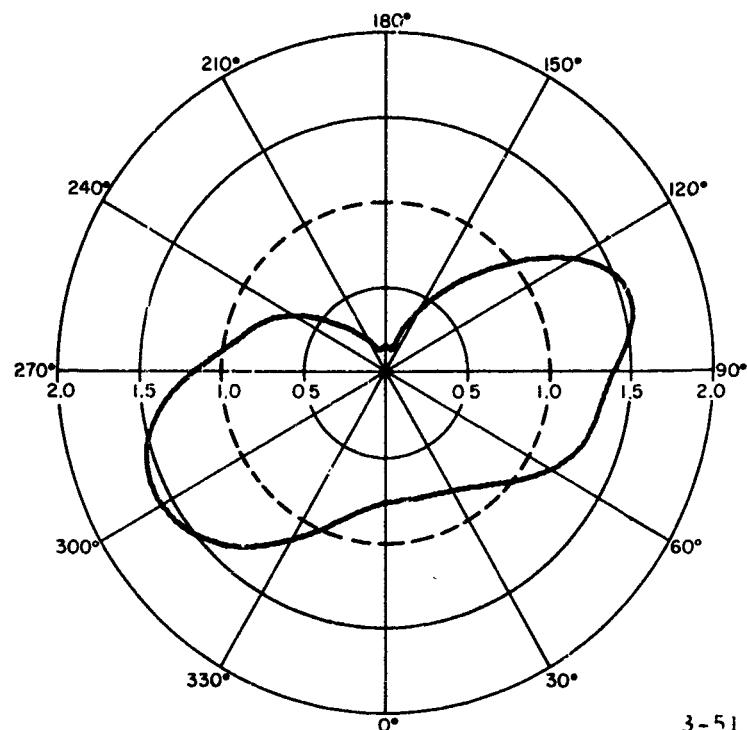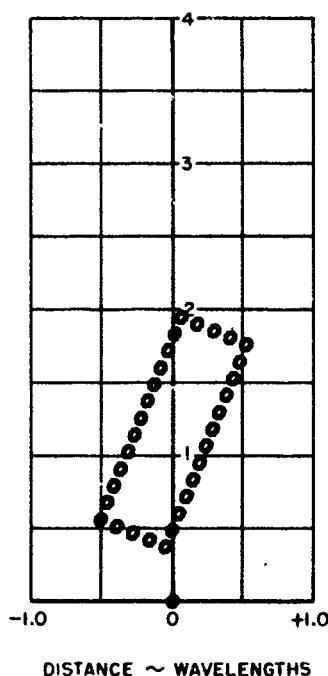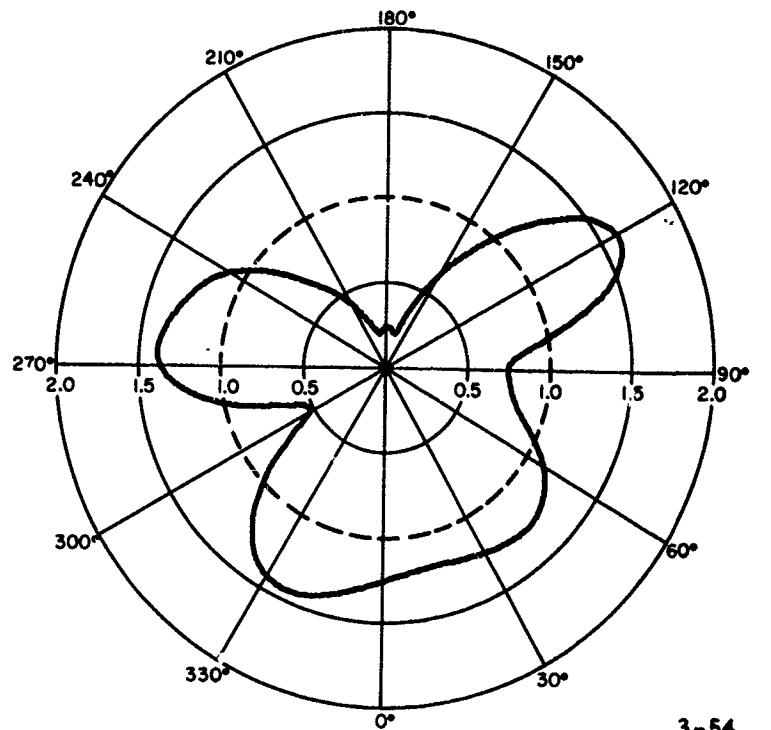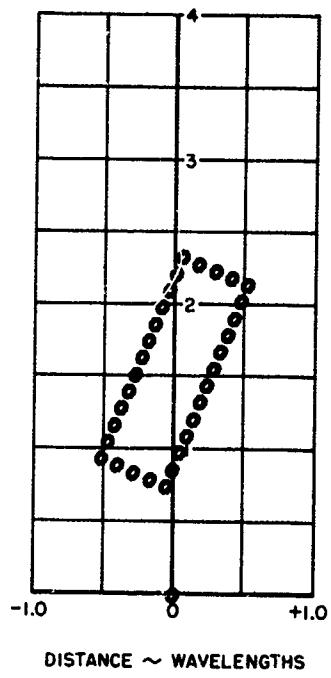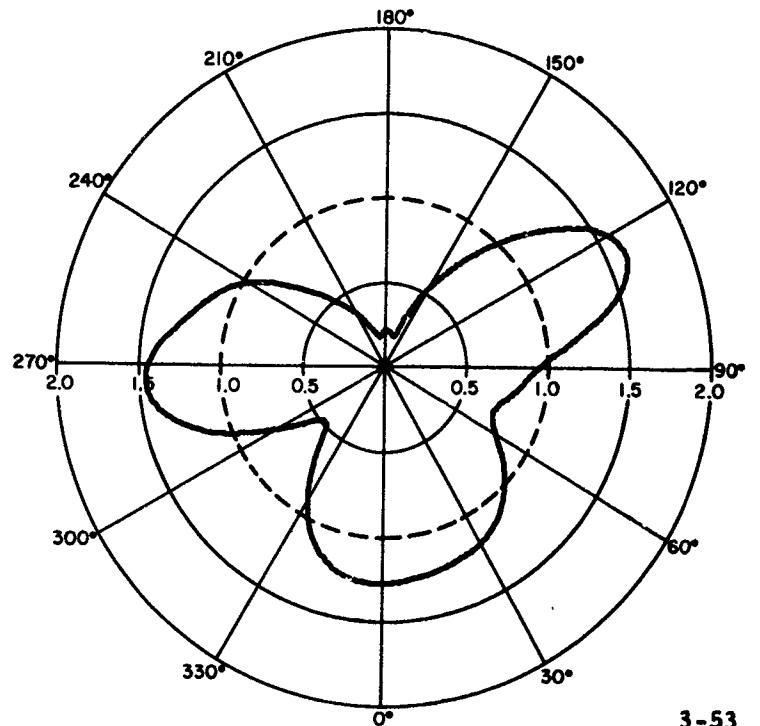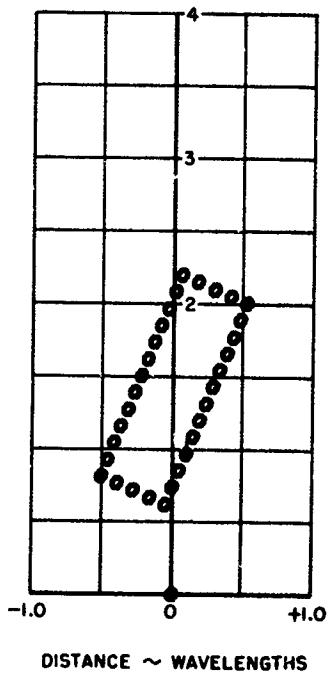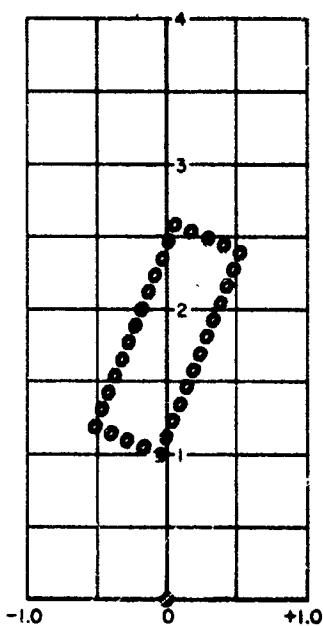
DISTANCE ~ WAVELENGTHS

3-56

DISTANCE ~ WAVELENGTHS

3-55

108

DISTANCE ~ WAVELENGTHS

3-58

DISTANCE ~ WAVELENGTHS

3-57

109
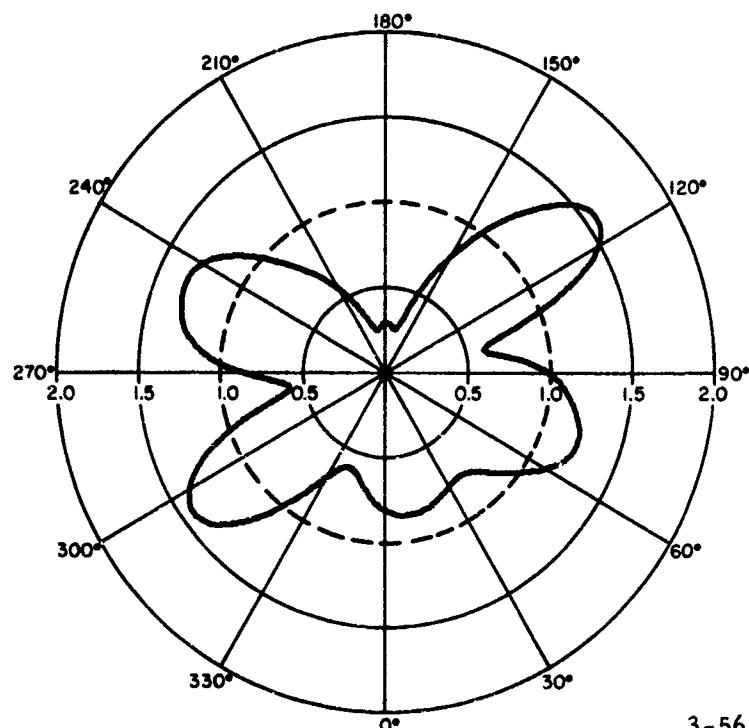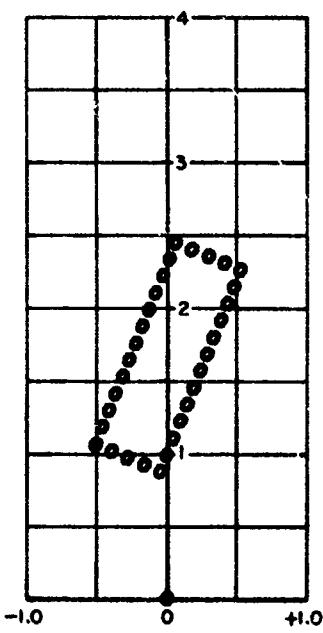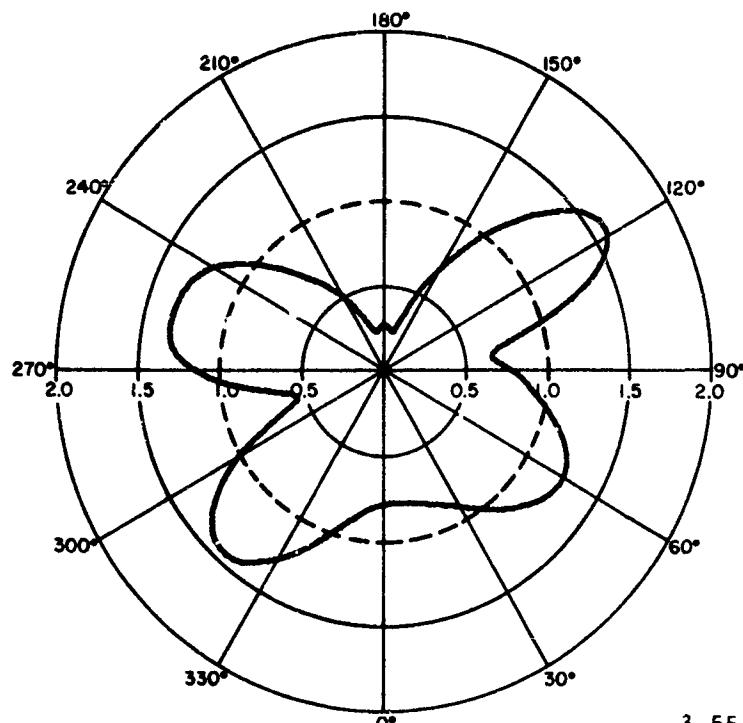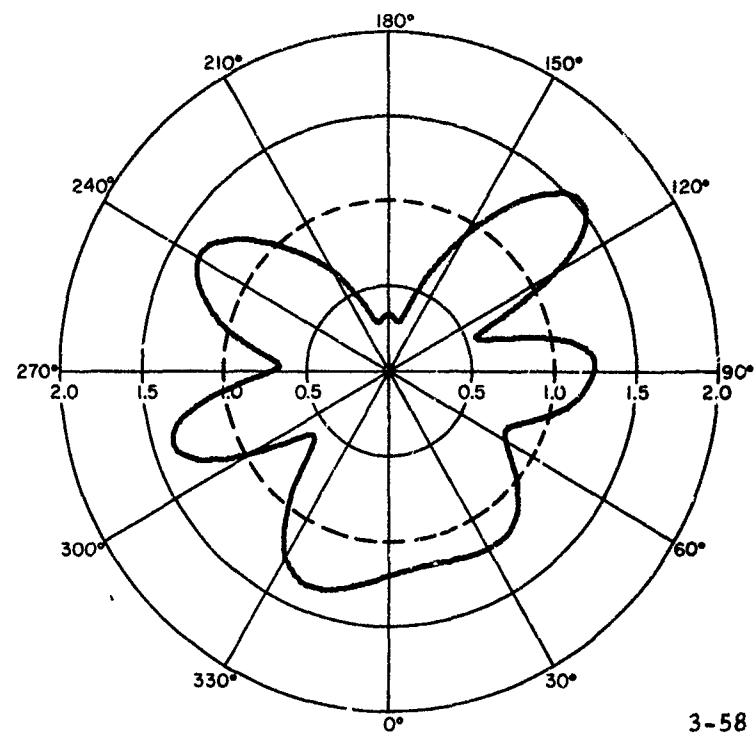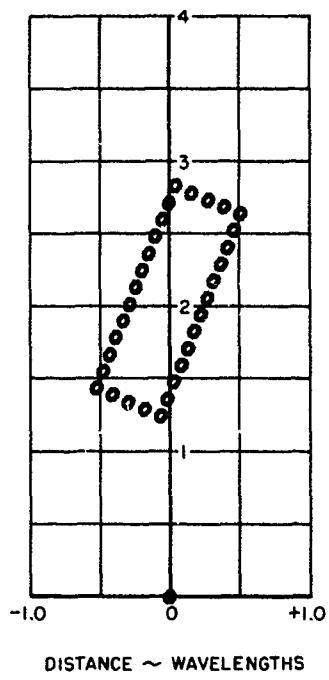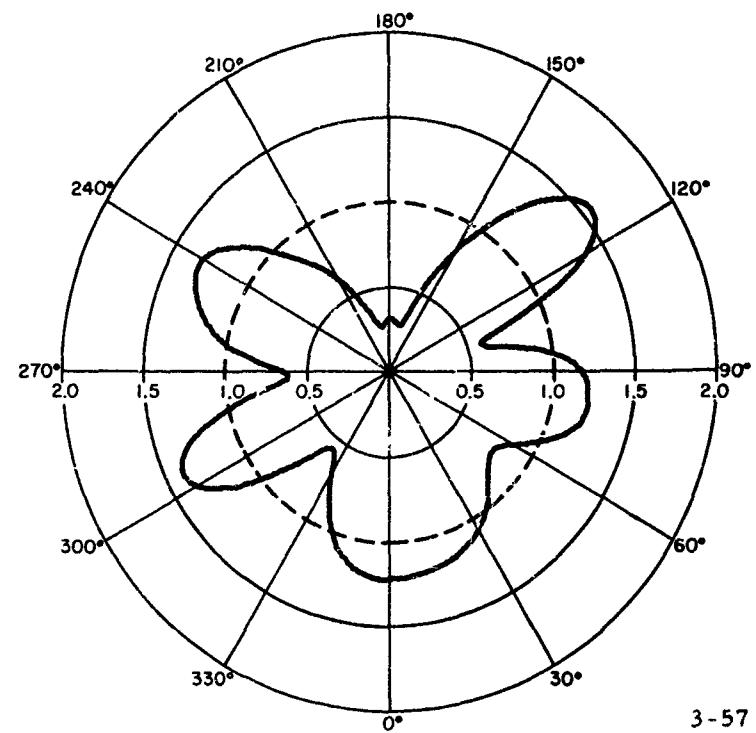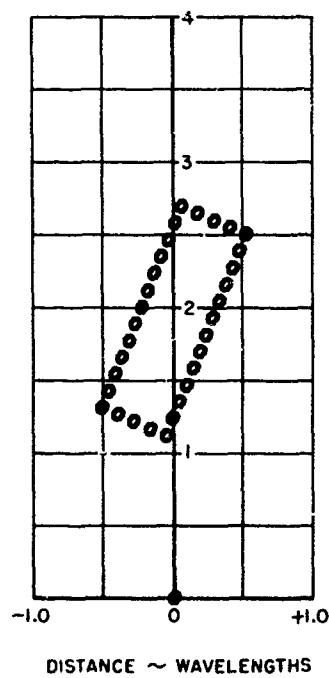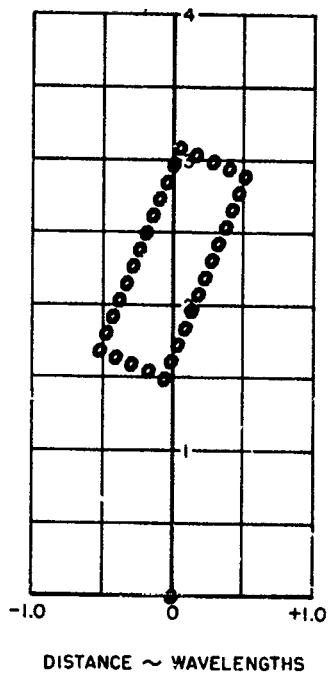
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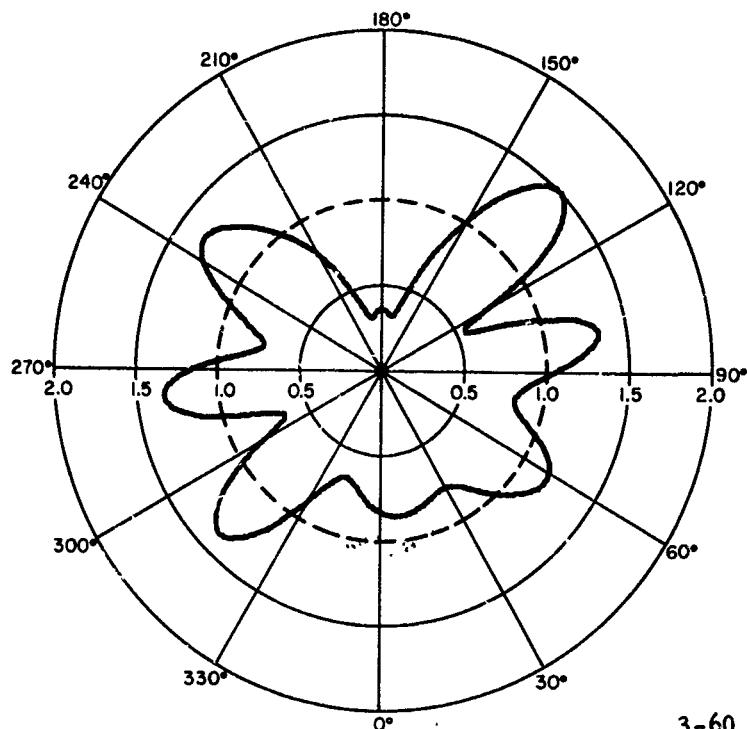
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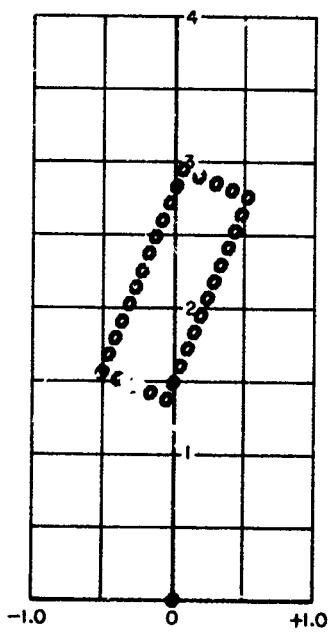
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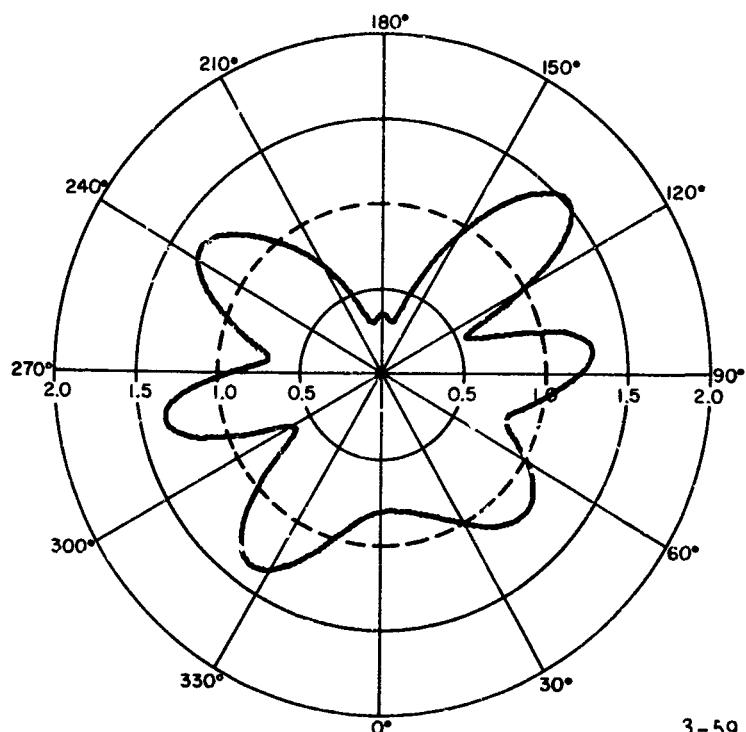
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110
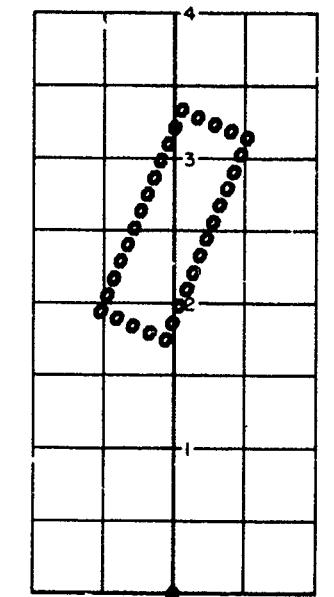
DISTANCE ~ WAVELENGTHS

3-62

DISTANCE ~ WAVELENGTHS

3-61

111

DISTANCE ~ WAVELENGTHS

3-64



DISTANCE ~ WAVELENGTHS

3-63

112
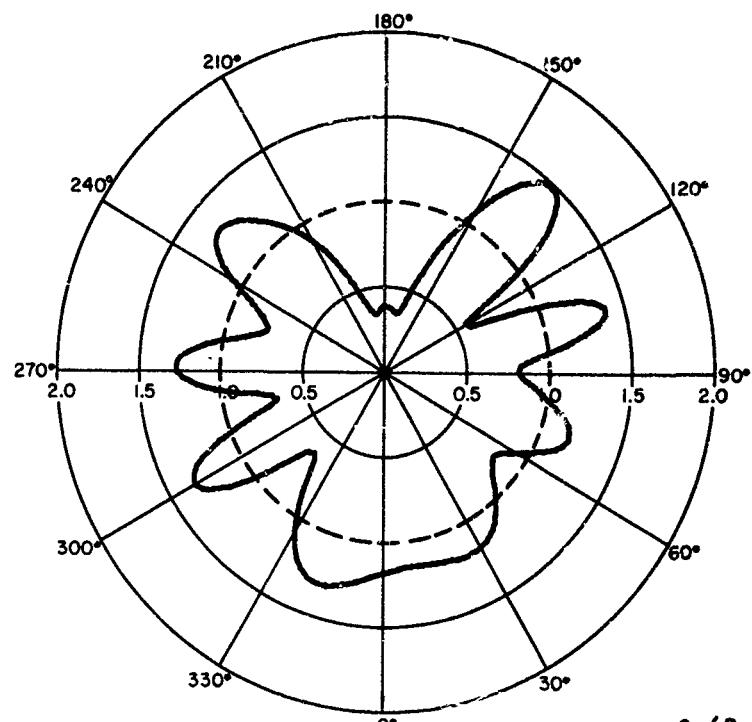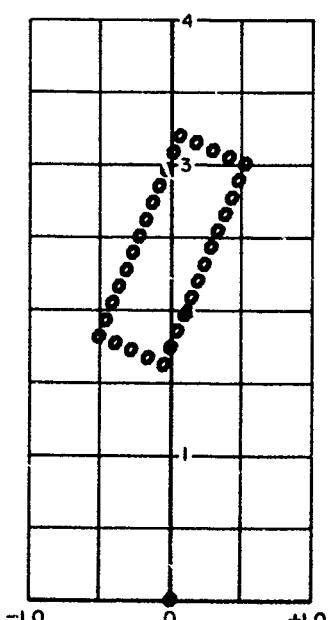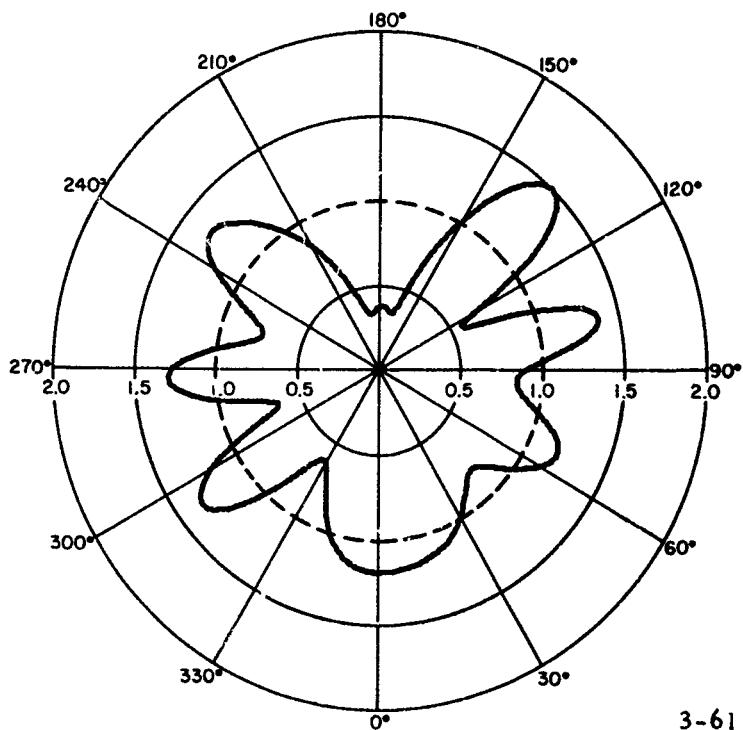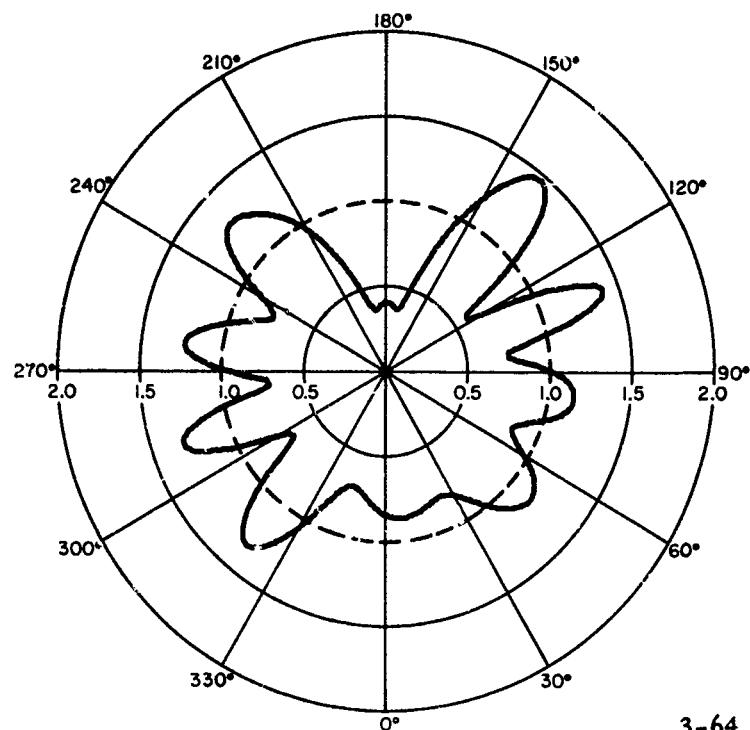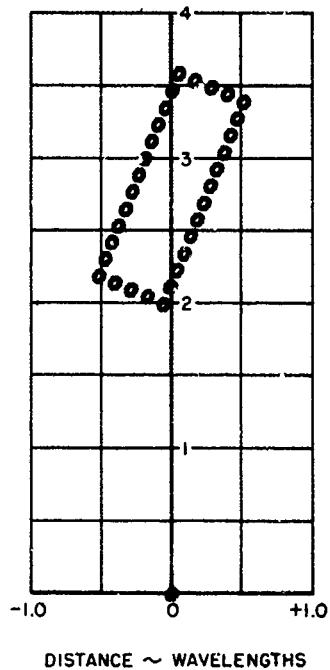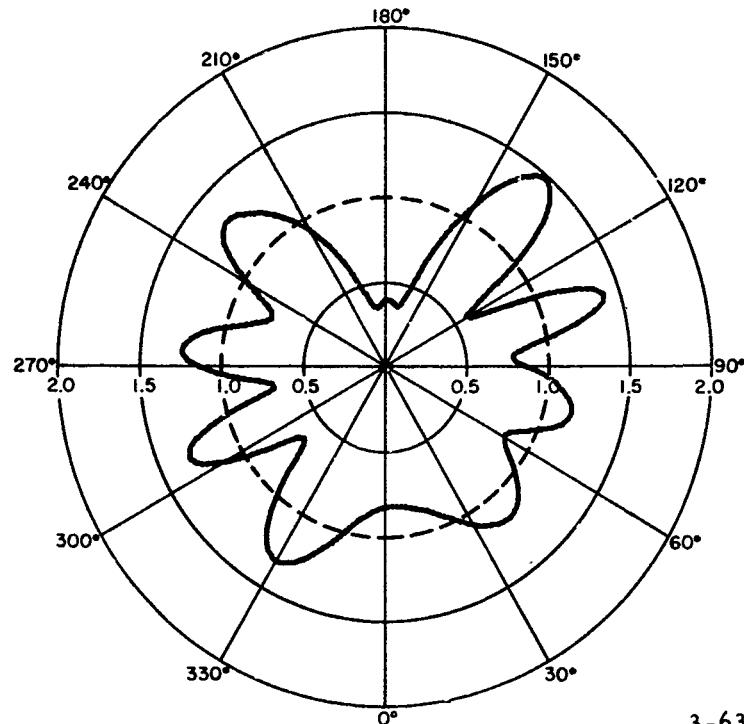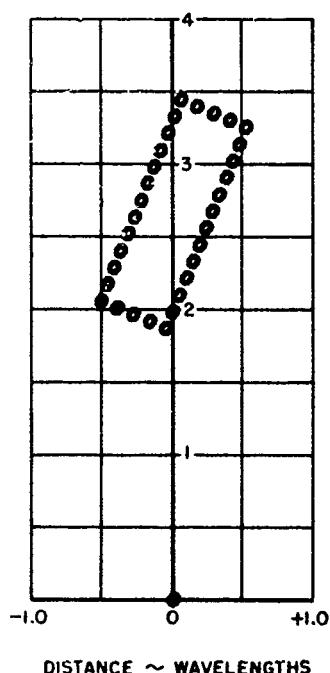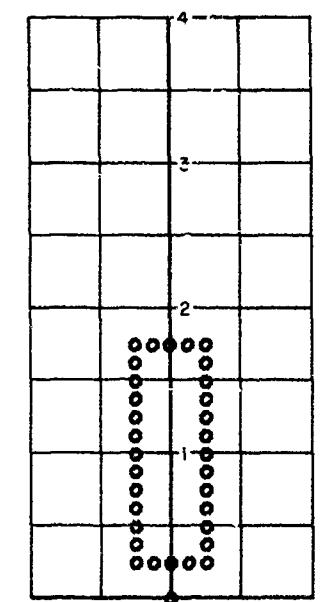
DISTANCE ~ WAVELENGTHS

3-66

DISTANCE ~ WAVELENGTHS

3-65

DISTANCE ~ WAVELENGTHS

3-68

DISTANCE ~ WAVELENGTHS

3-67

114

DISTANCE ~ WAVELENGTHS

3-70

DISTANCE ~ WAVELENGTHS

3-69

115
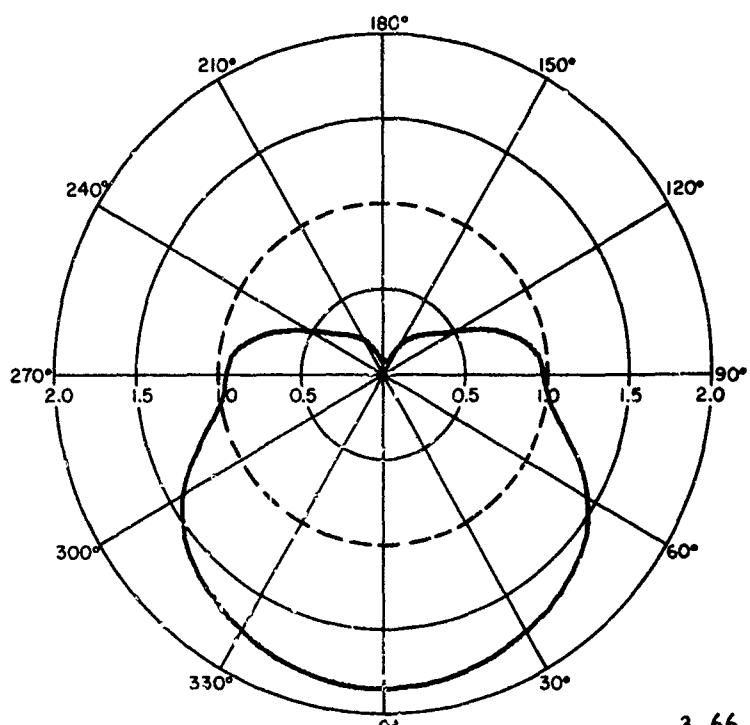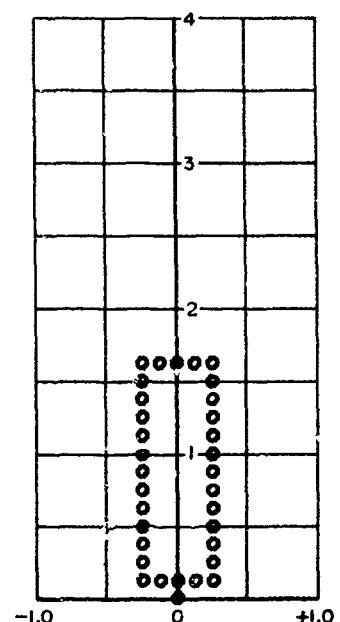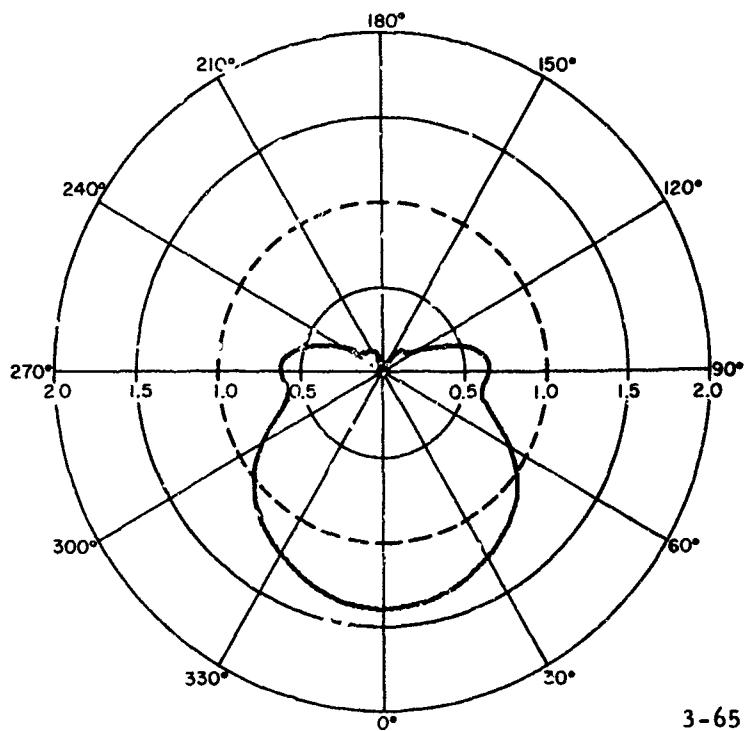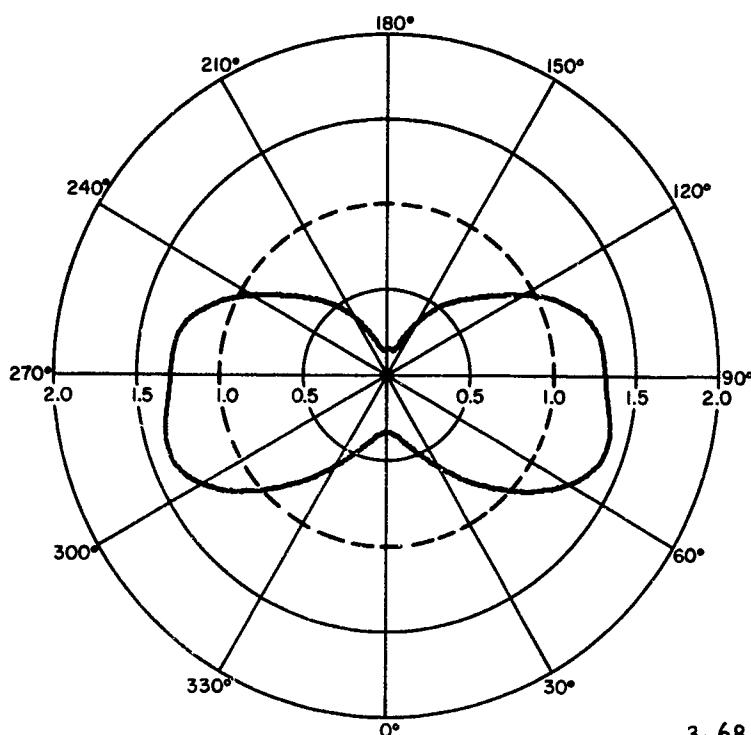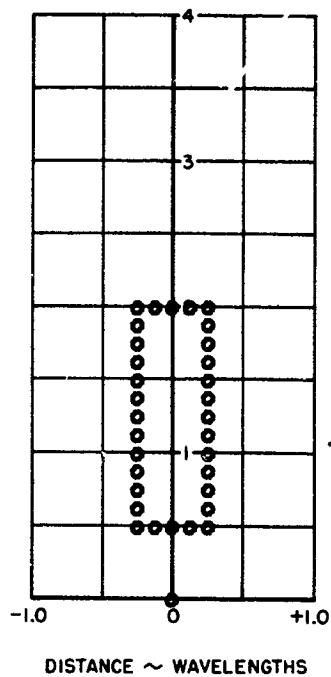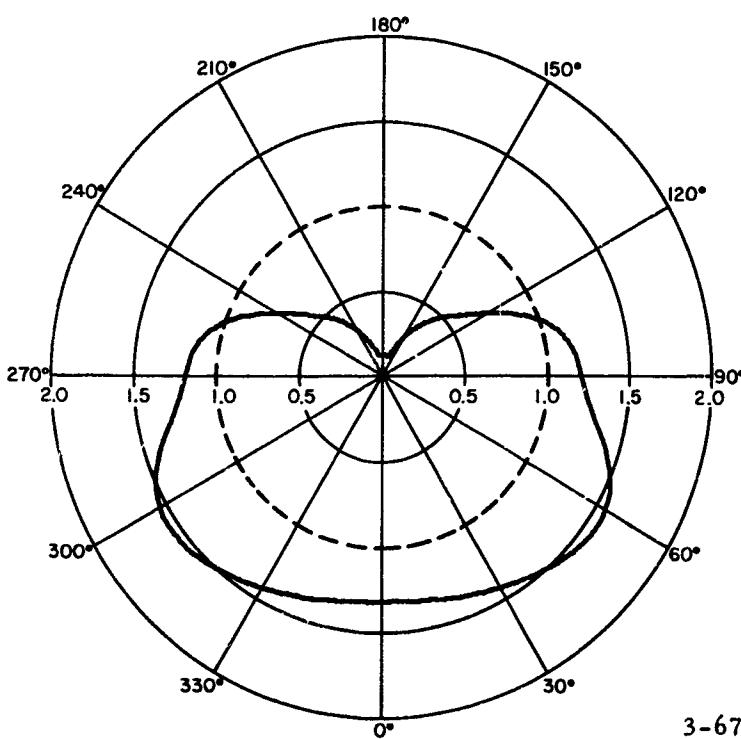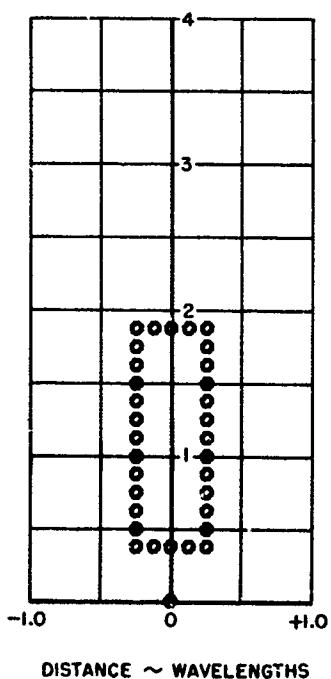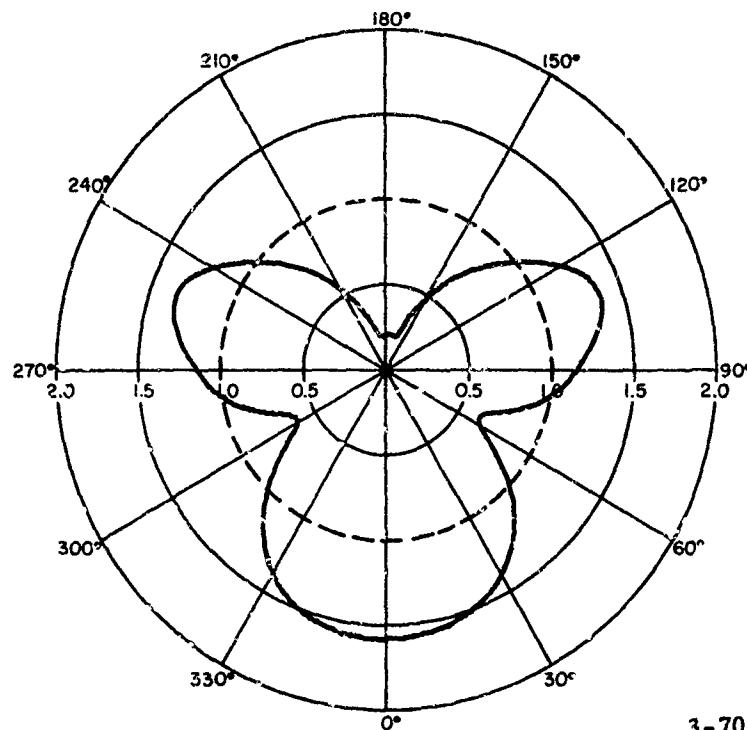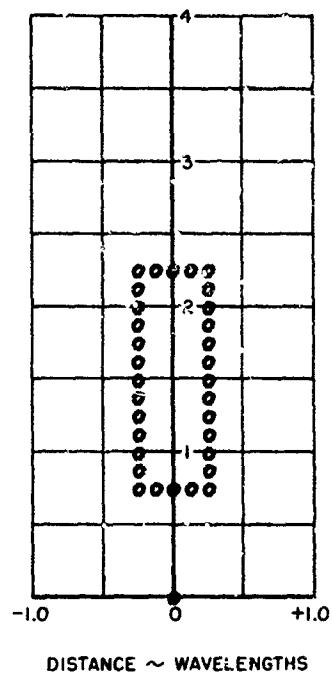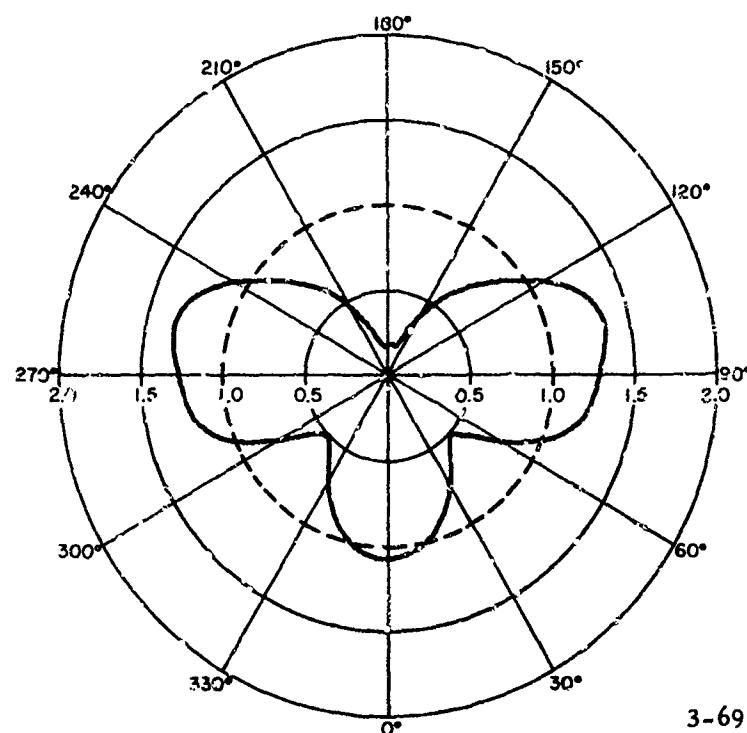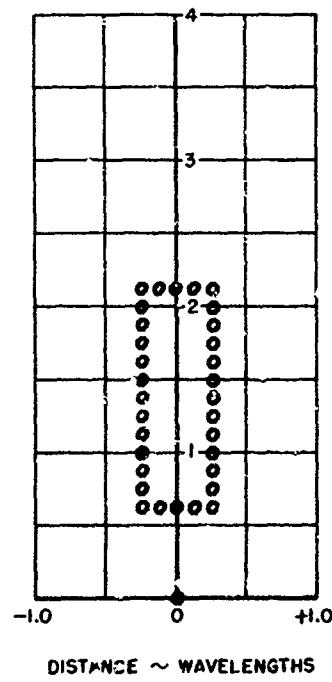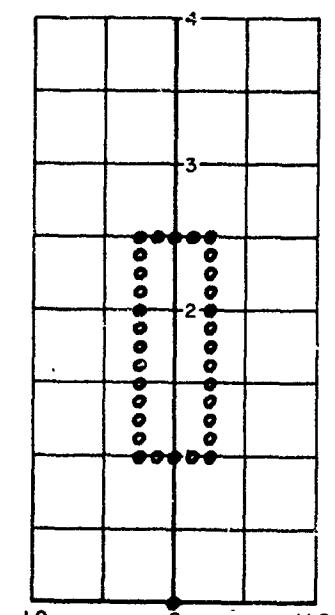
DISTANCE ~ WAVELENGTHS

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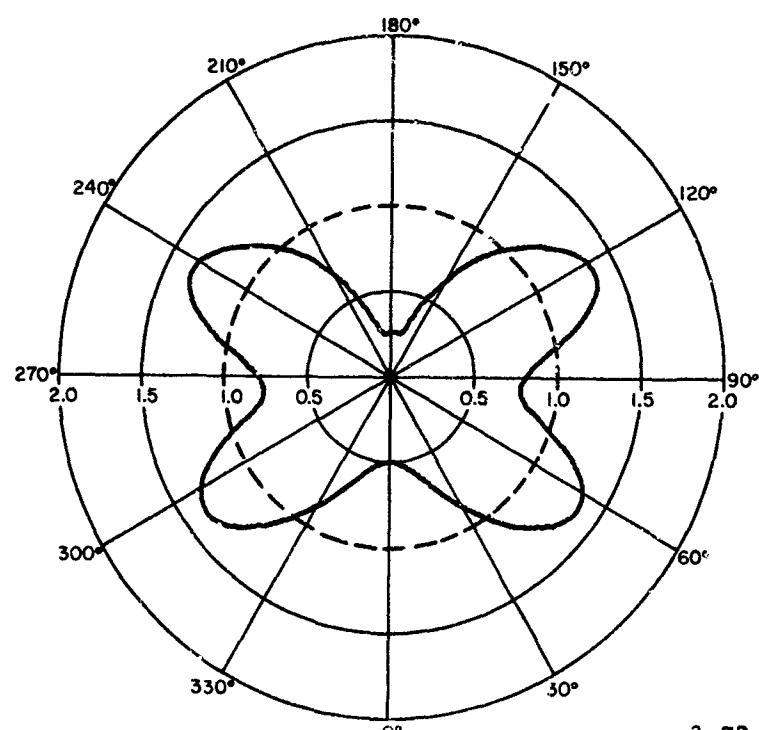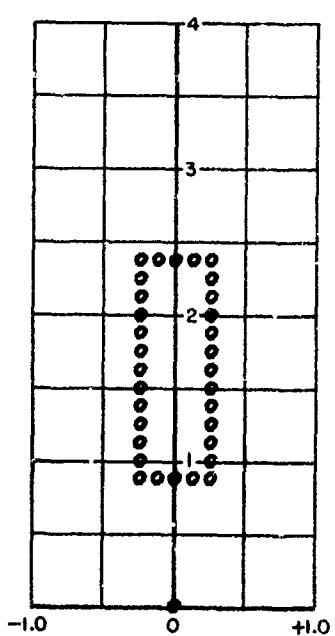
DISTANCE ~ WAVELENGTHS

3-71

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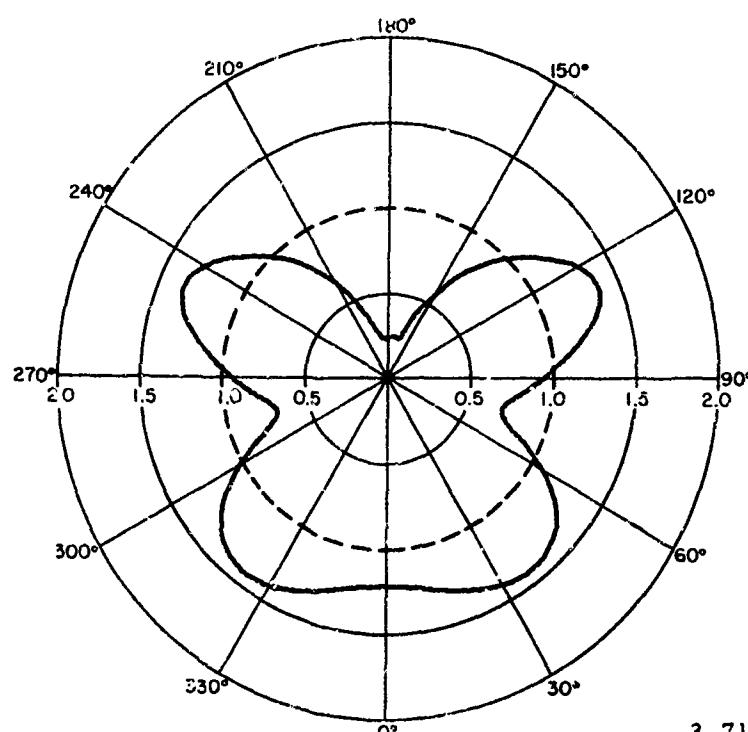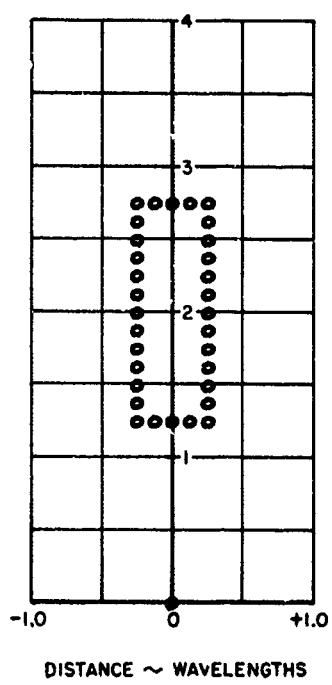
DISTANCE ~ WAVELENGTHS

3-74

DISTANCE ~ WAVELENGTHS

3-73

117

DISTANCE ~ WAVELENGTHS

3-76

DISTANCE ~ WAVELENGTHS

3-75

118

DISTANCE ~ WAVELENGTHS

3-78

DISTANCE ~ WAVELENGTHS

3-77

119

DISTANCE ~ WAVELENGTHS

3-80

DISTANCE ~ WAVELENGTHS

3-79

120
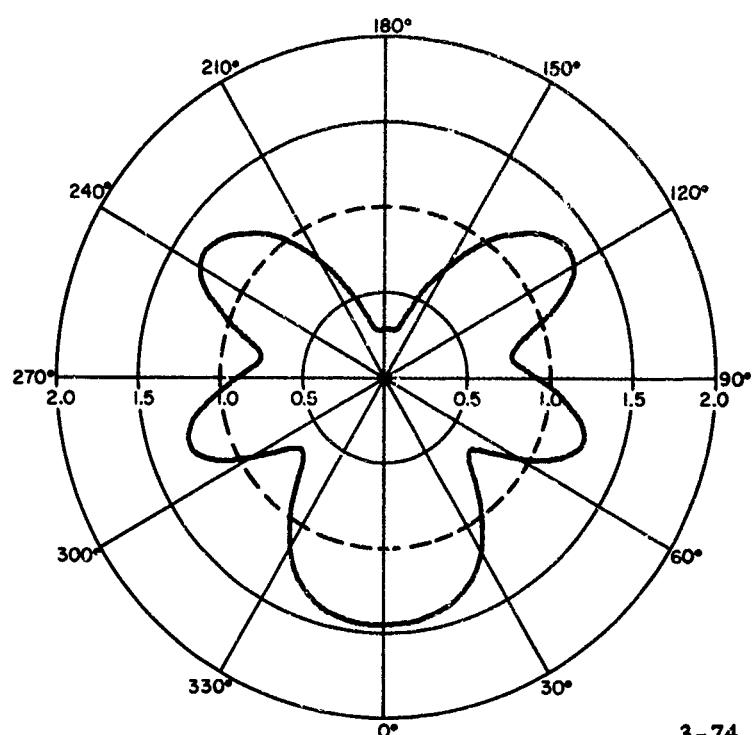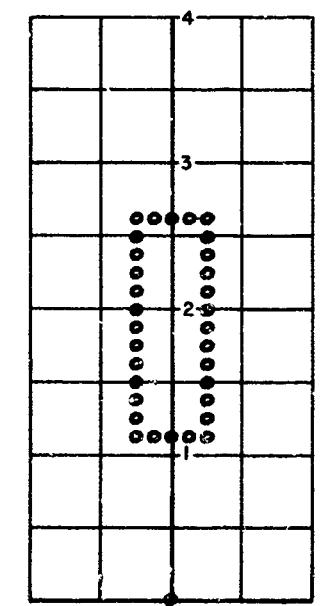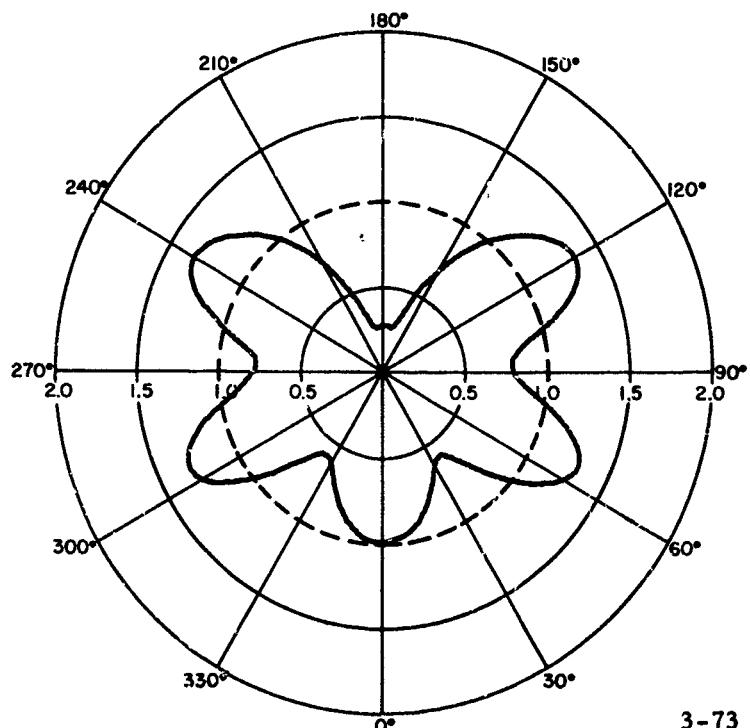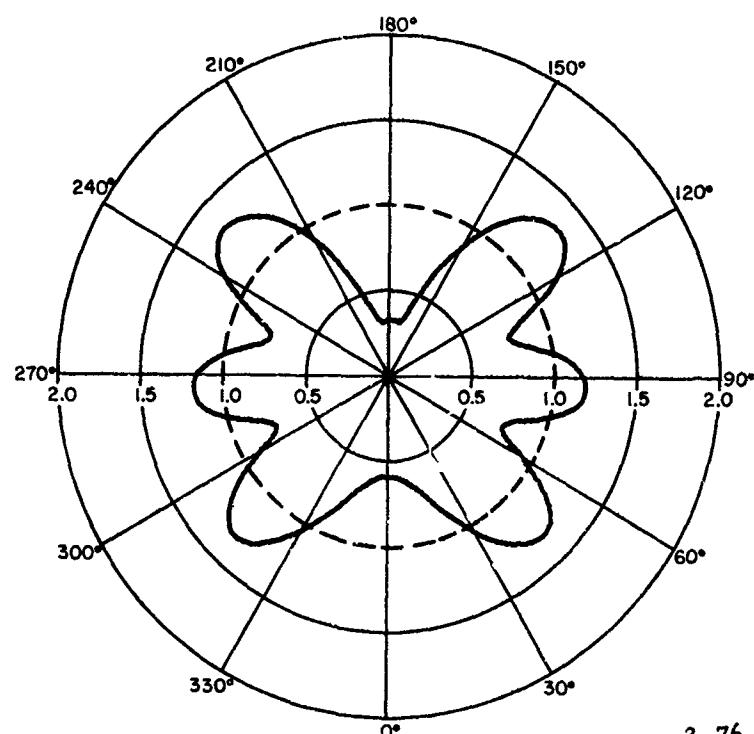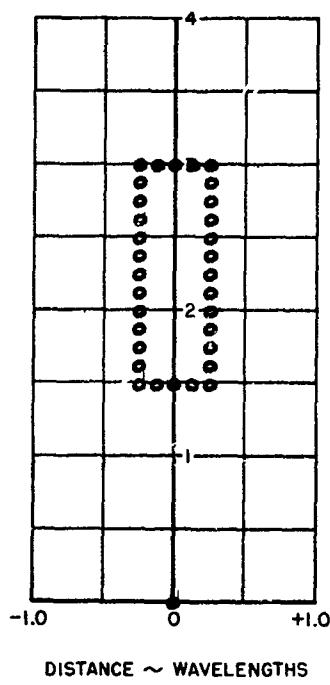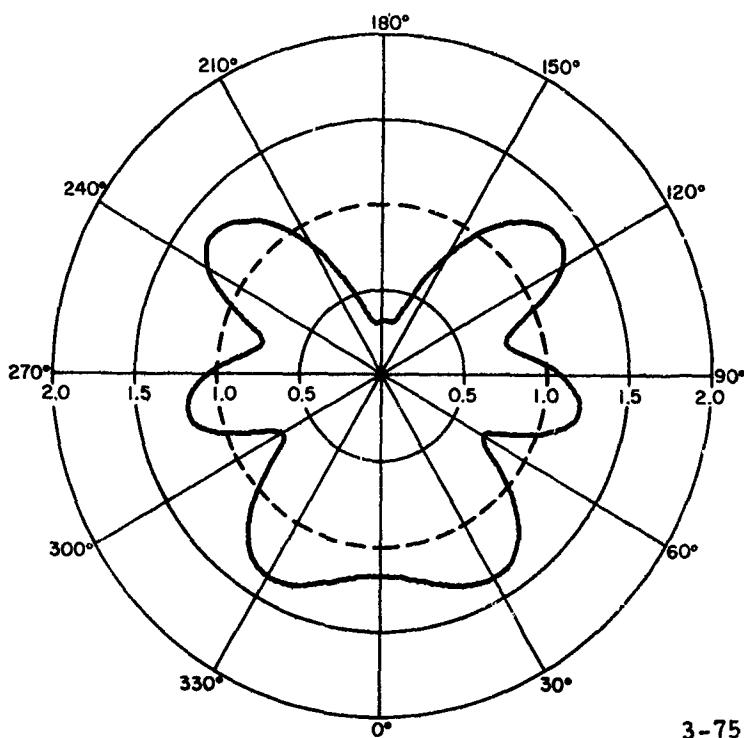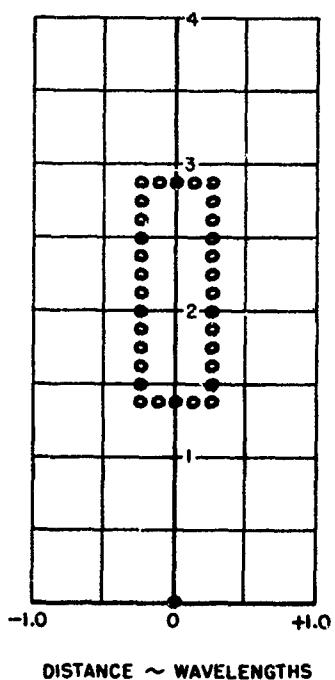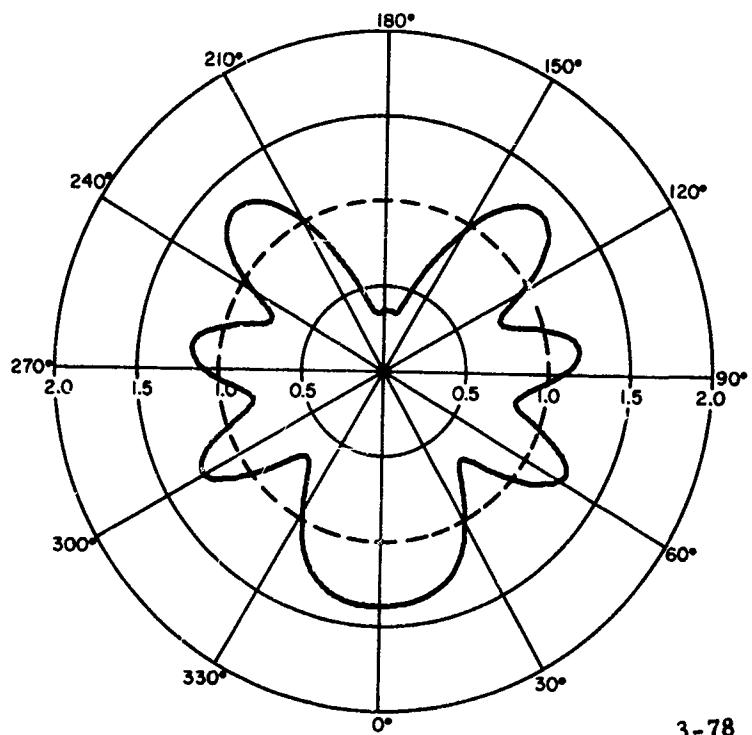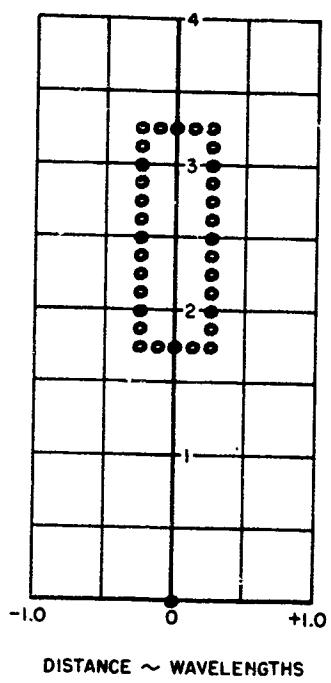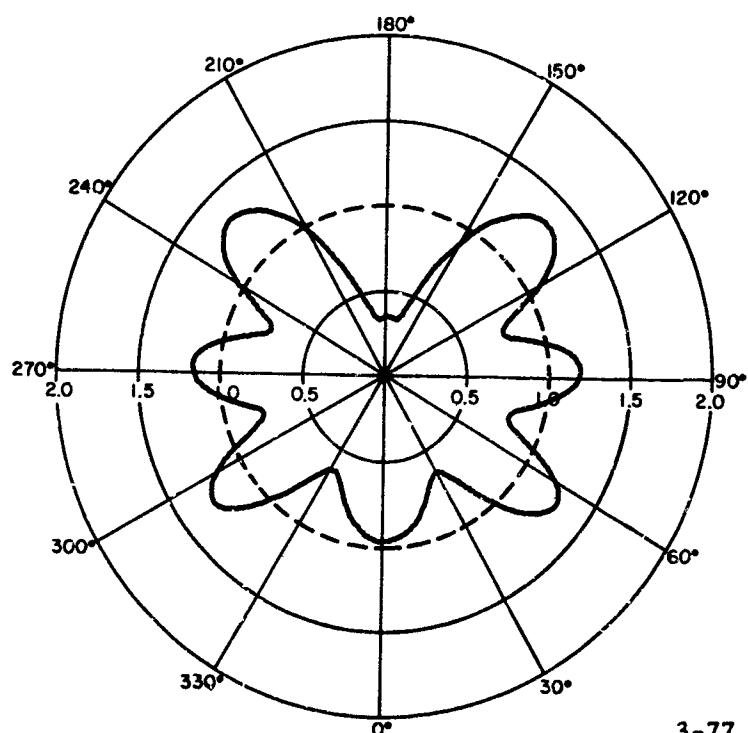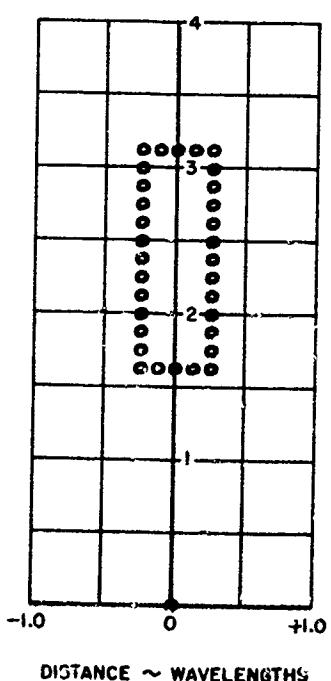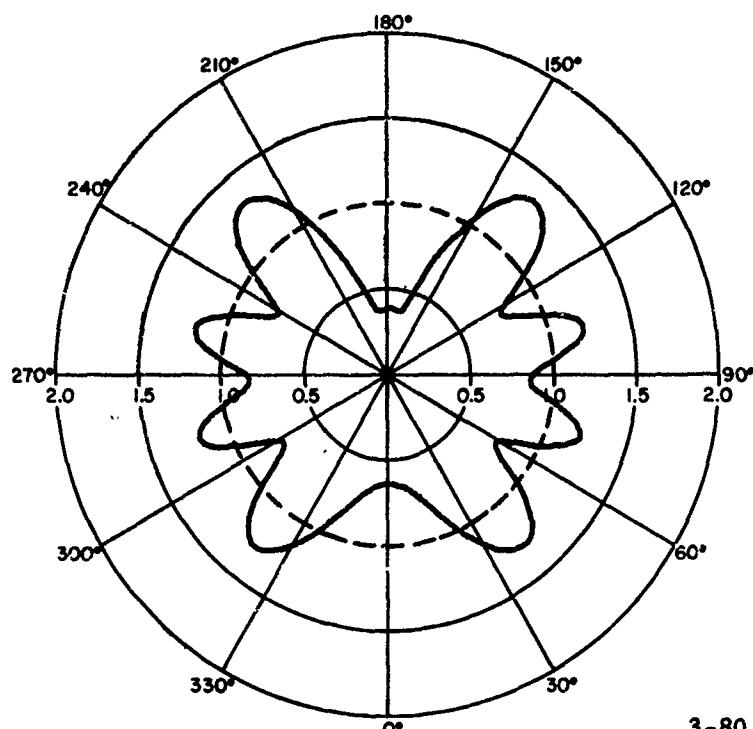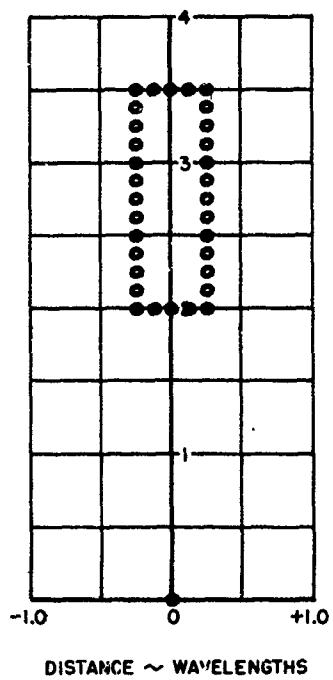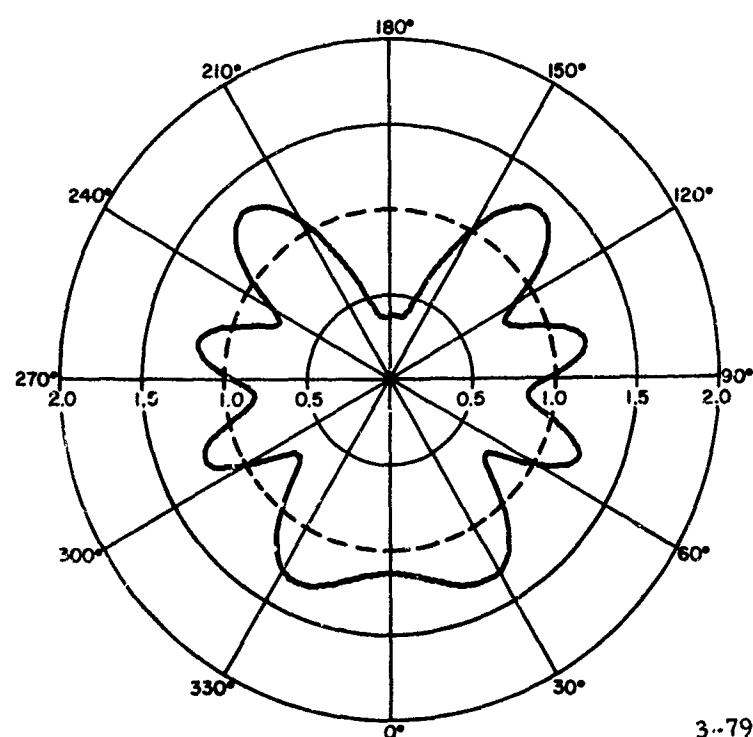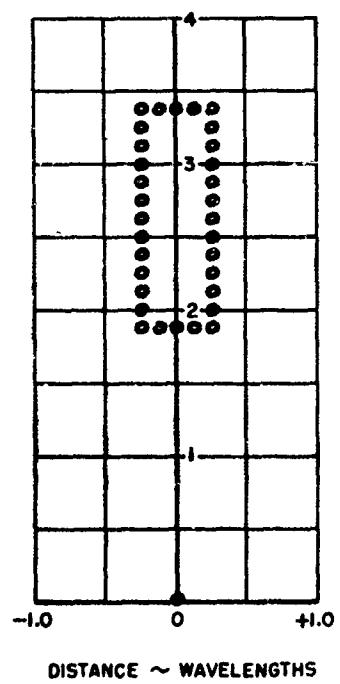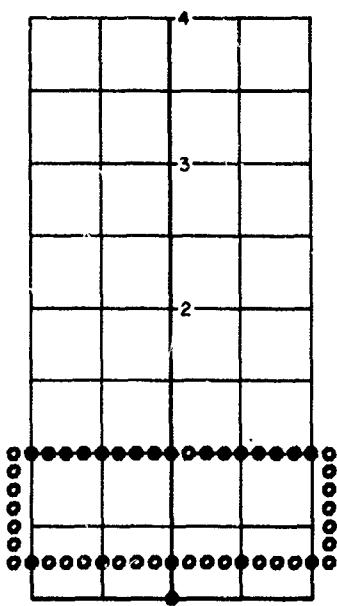
DISTANCE ~ WAVELENGTHS

4-2

DISTANCE ~ WAVELENGTHS

4-1

121
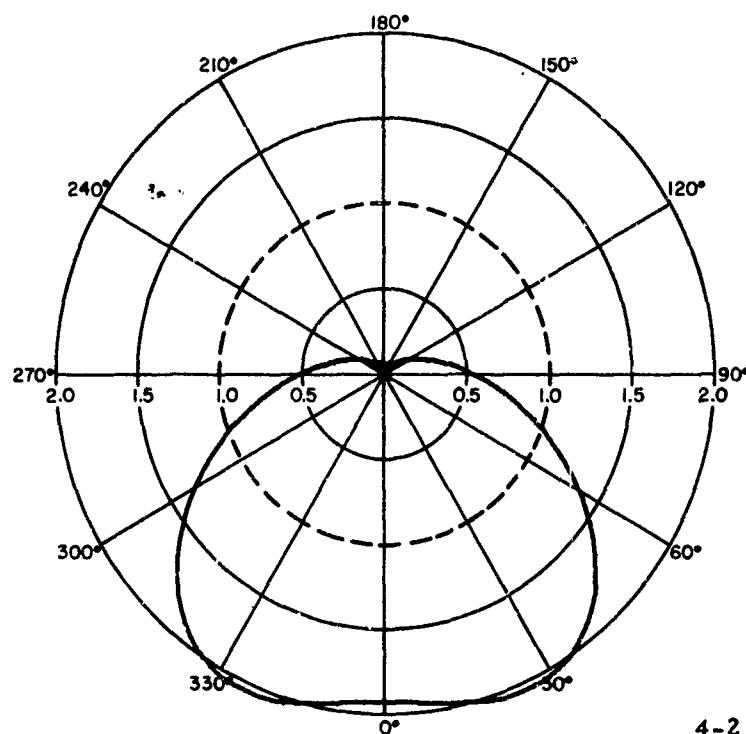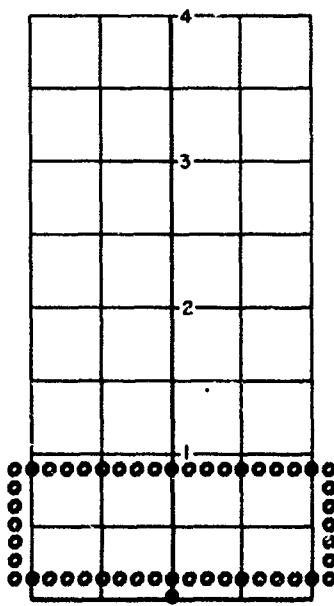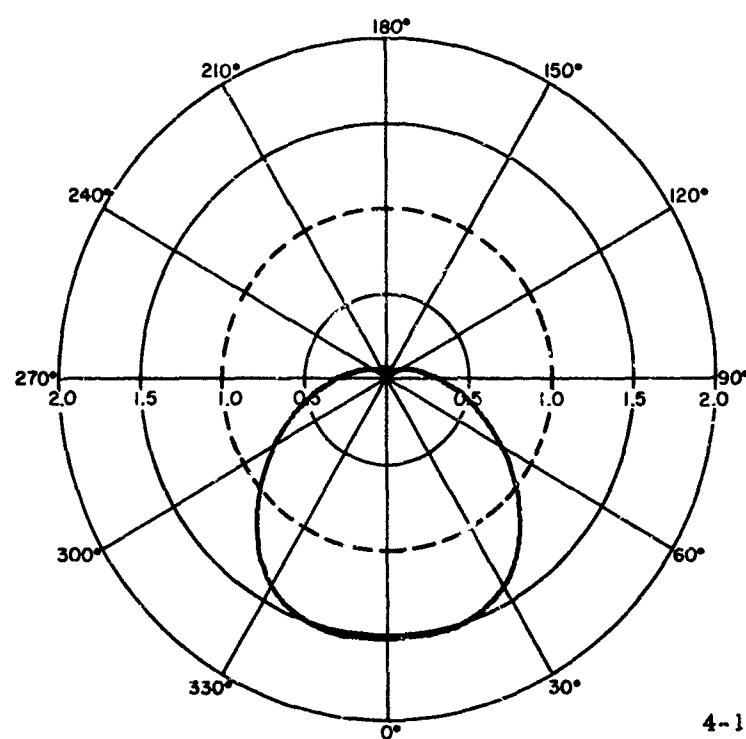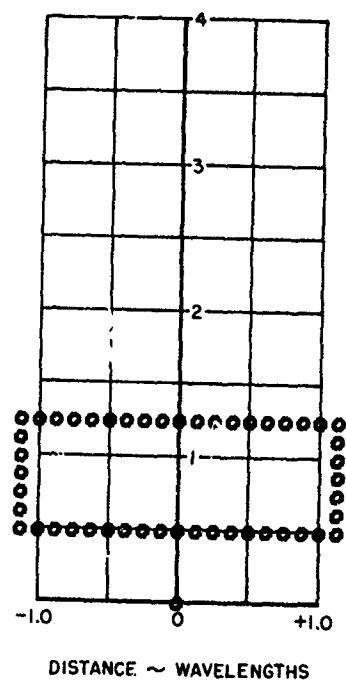
DISTANCE ~ WAVELENGTHS

4-4

DISTANCE ~ WAVELENGTHS

4-3

122

DISTANCE ∼ WAVELENGTHS

4-6

DISTANCE ∼ WAVELENGTHS

4-5

123

DISTANCE ～ WAVELENGTHS

4-8

DISTANCE ～ WAVELENGTHS

4-7

124
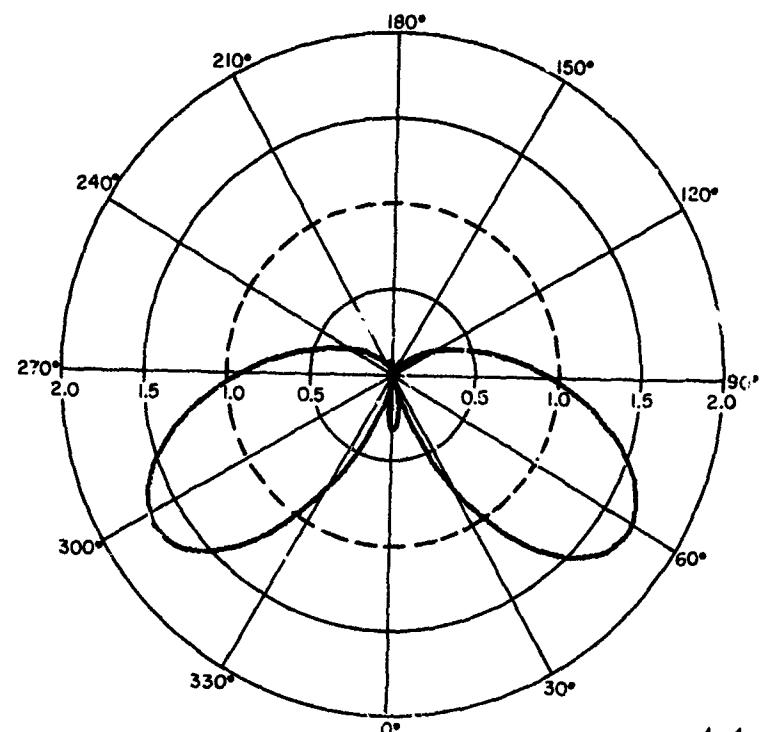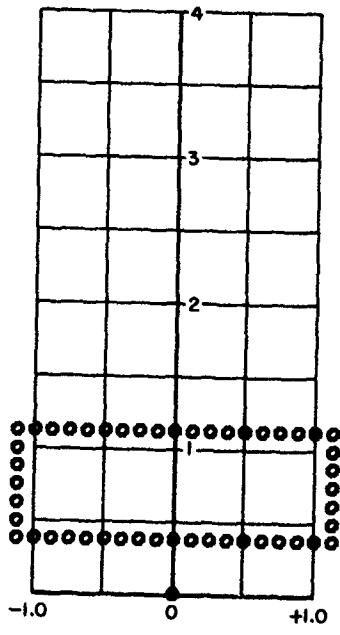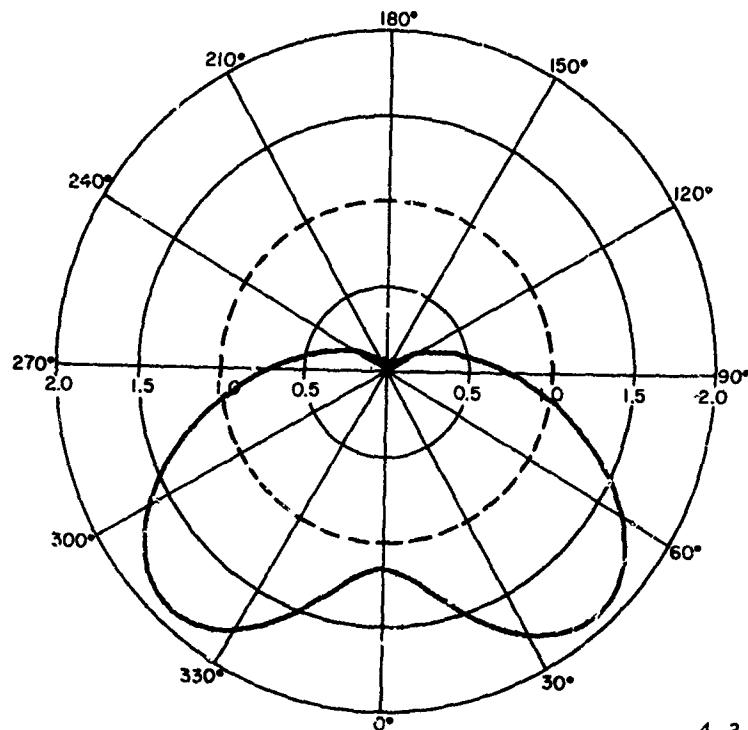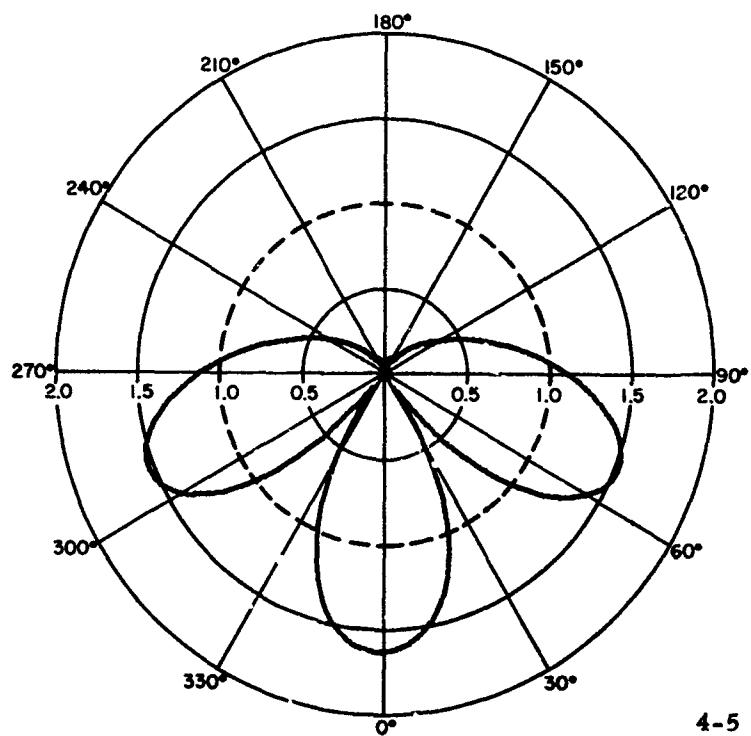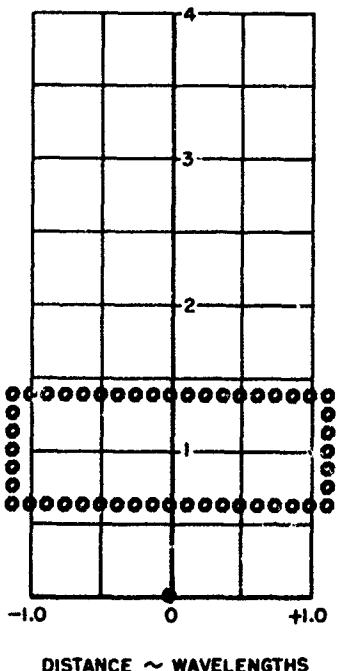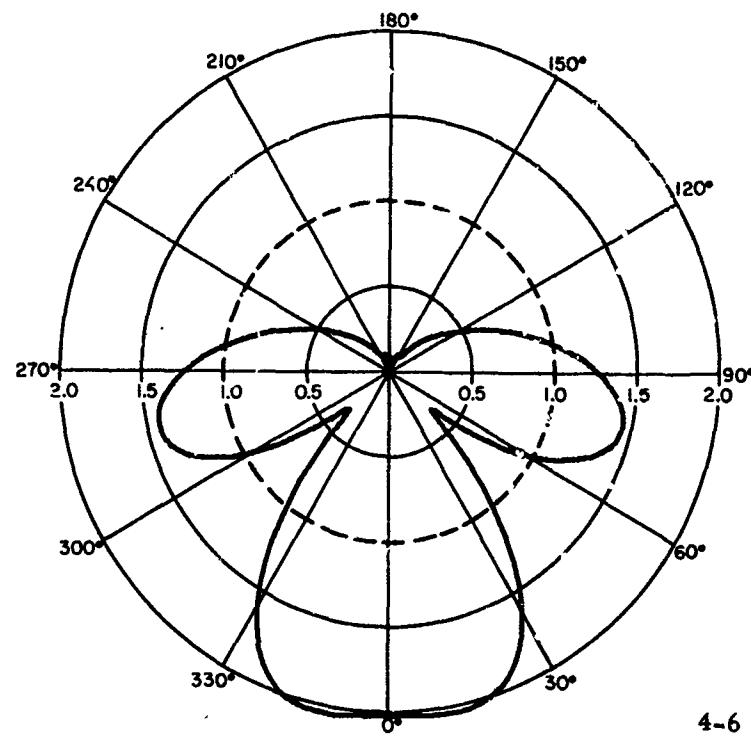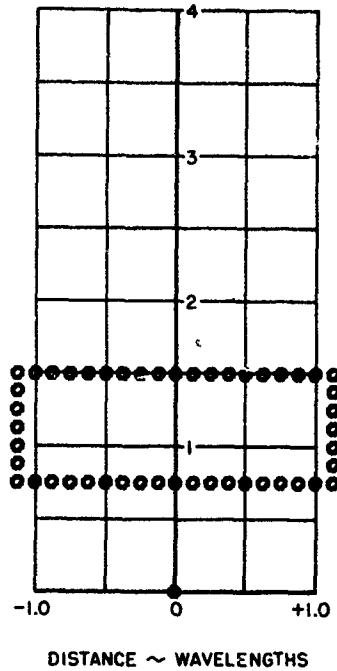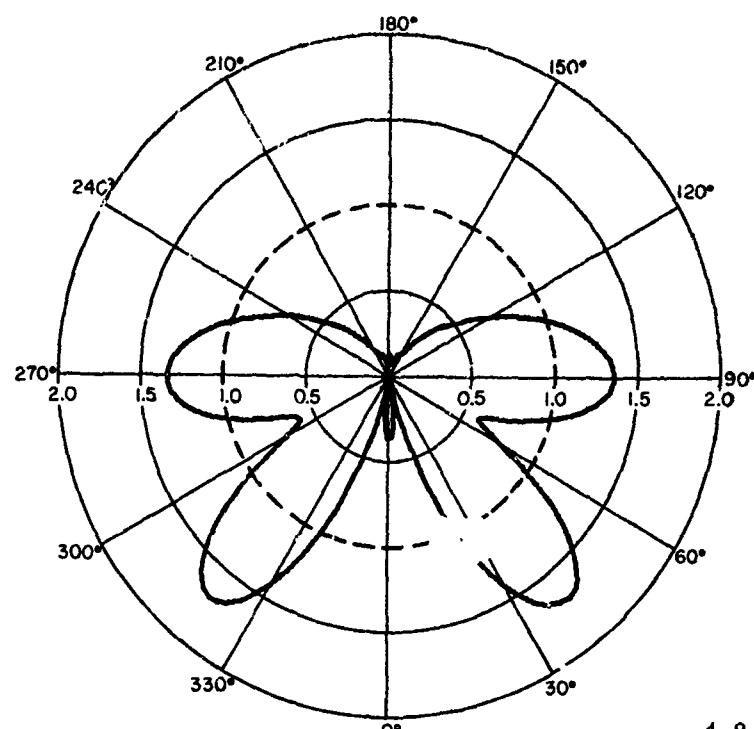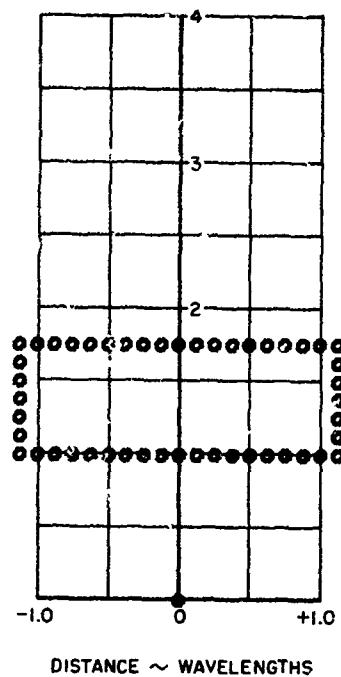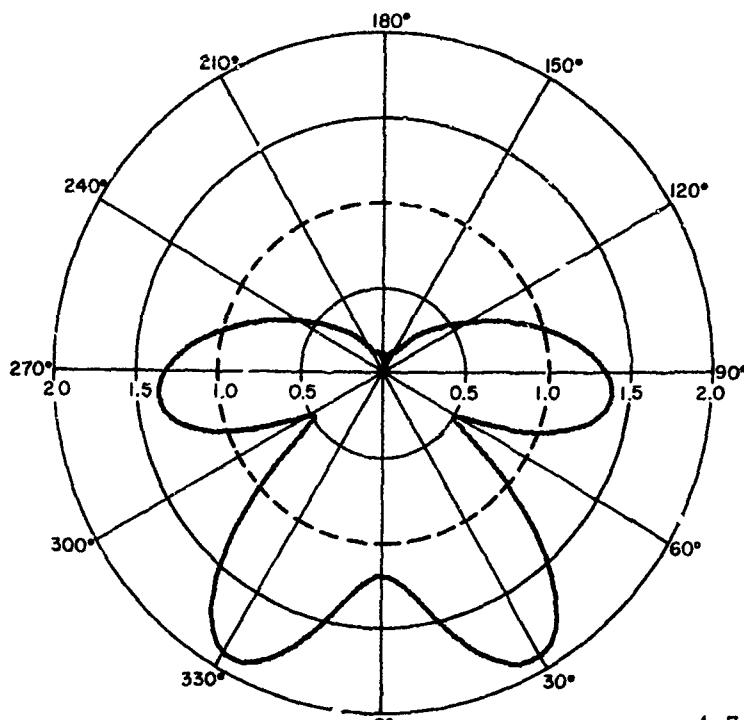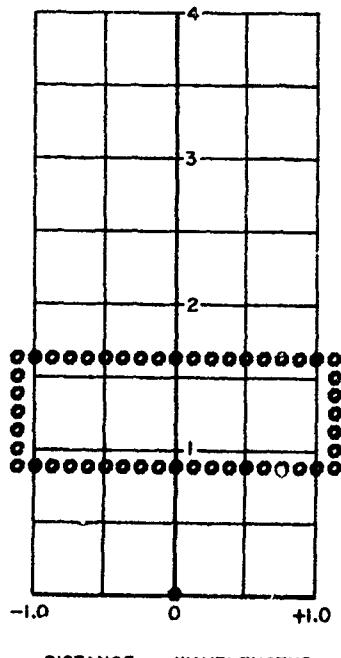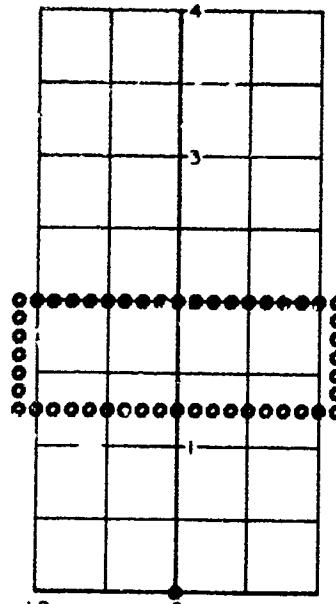
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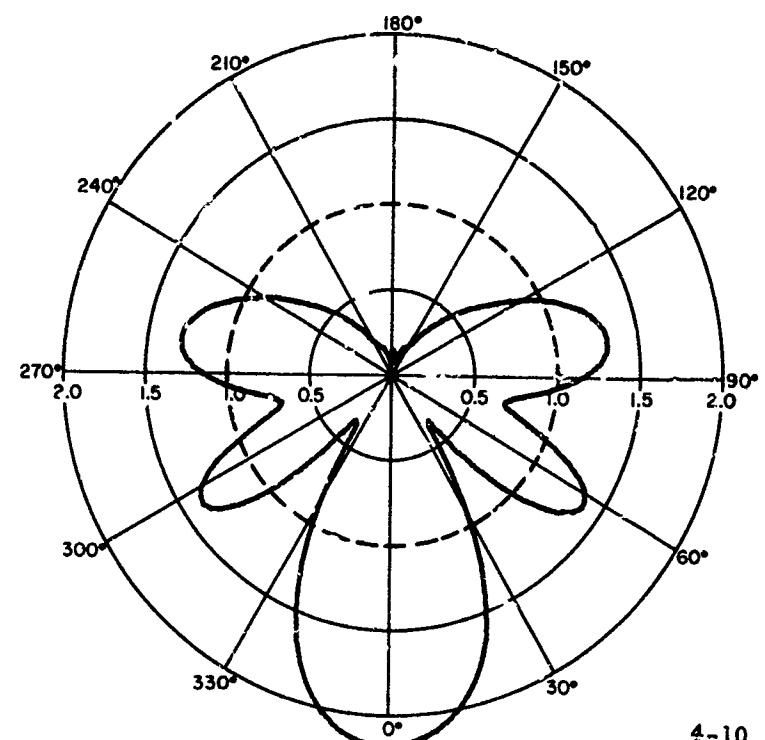
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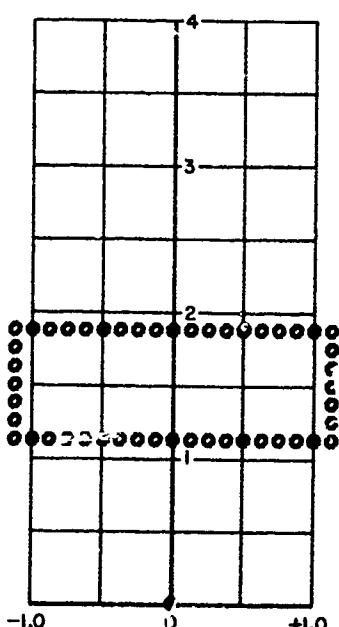
DISTANCE ~ WAVELENGTHS

4-9

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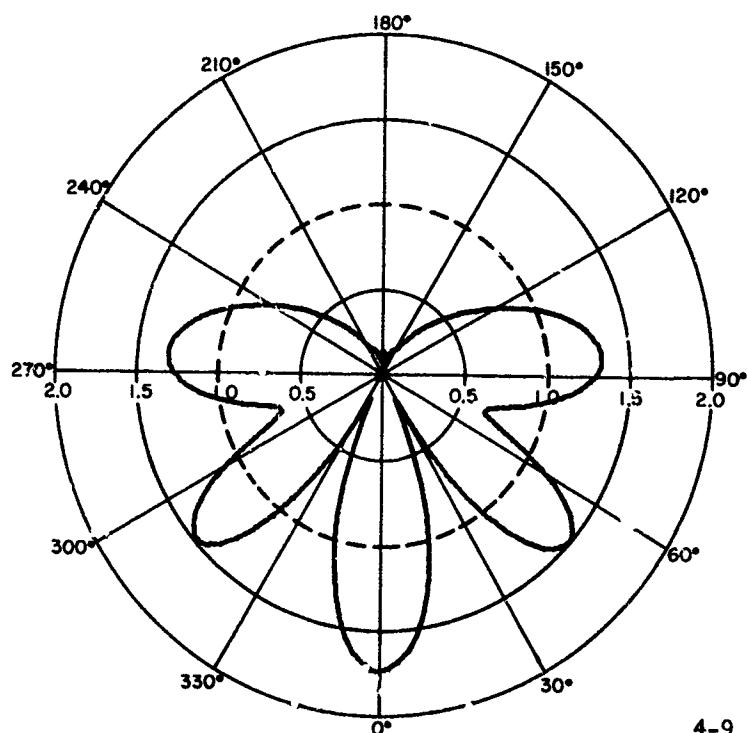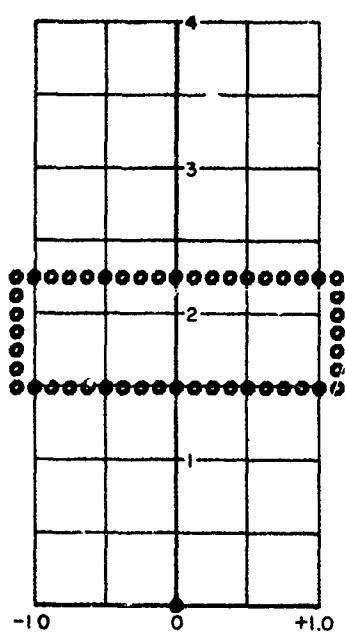
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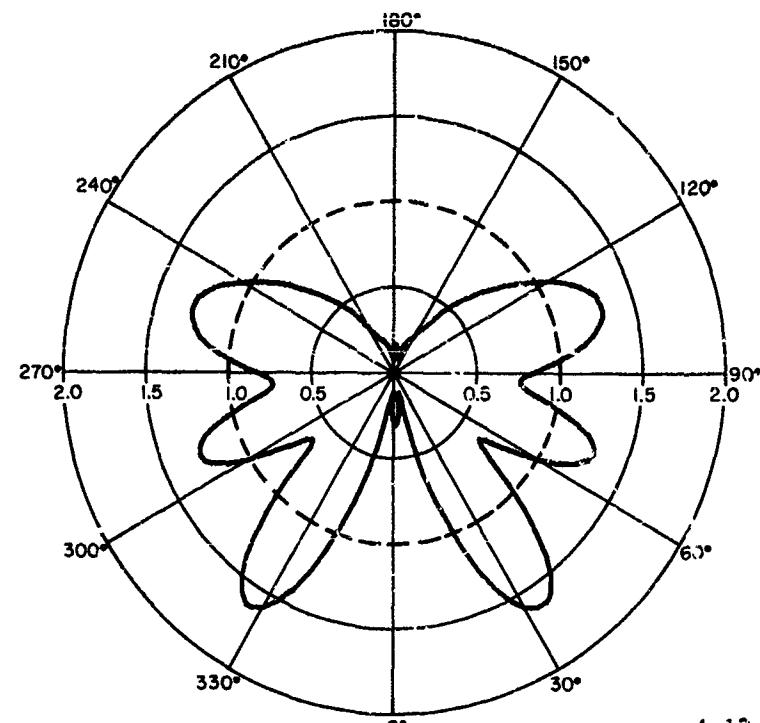
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DISTANCE ~ WAVELENGTHS

4-11

126
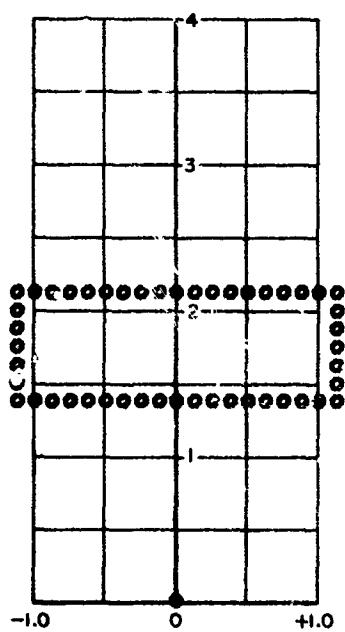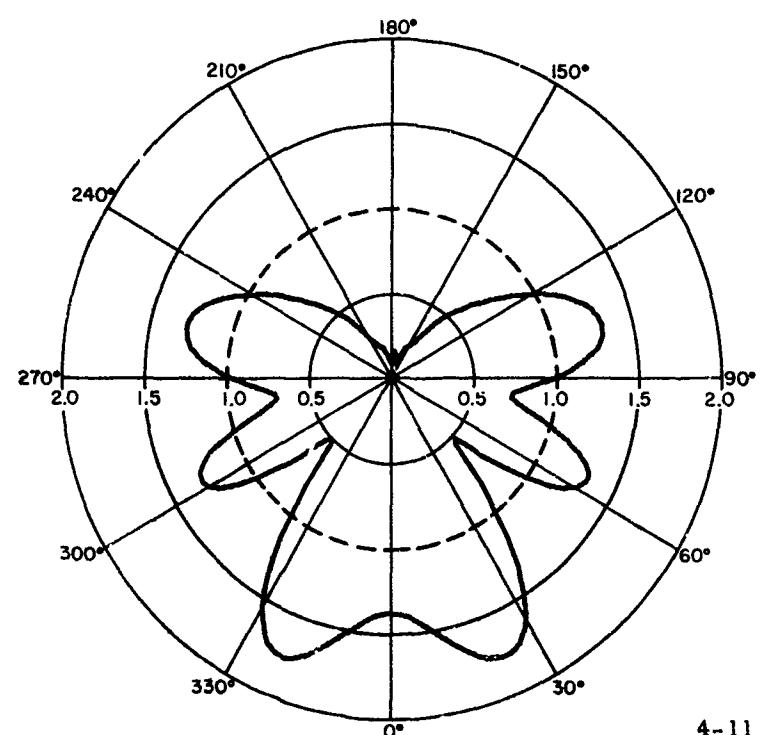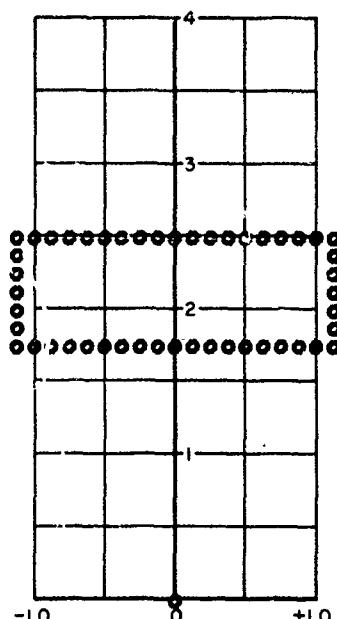
DISTANCE ~ WAVELENGTHS
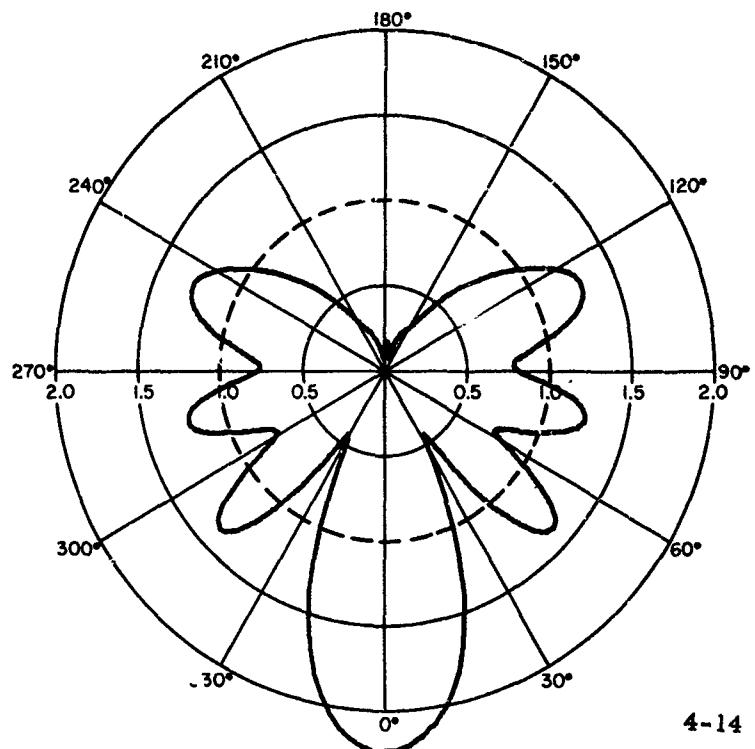
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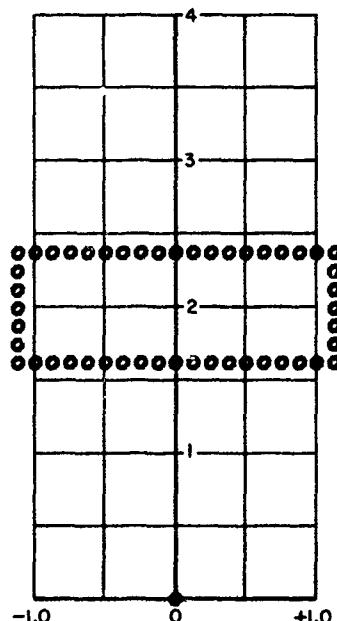
DISTANCE ~ WAVELENGTHS

4-13

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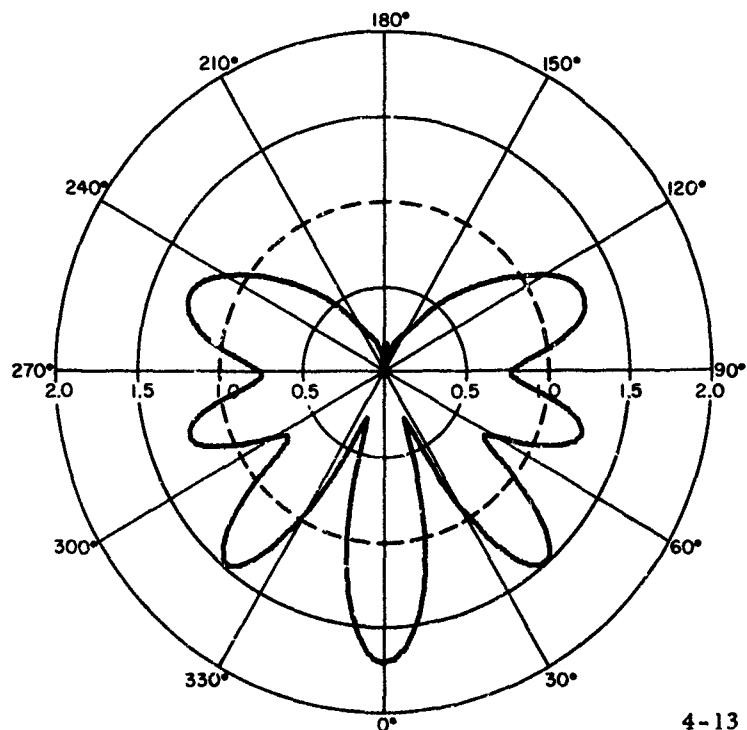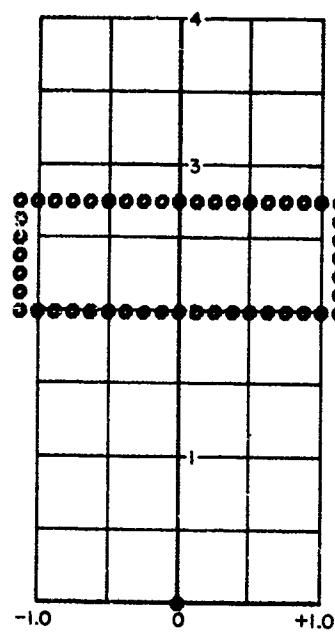
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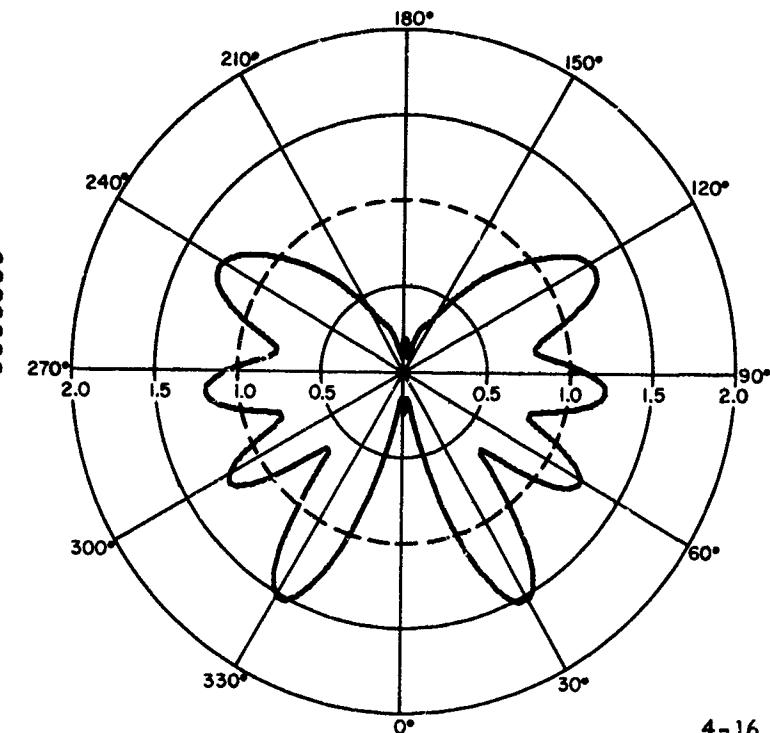
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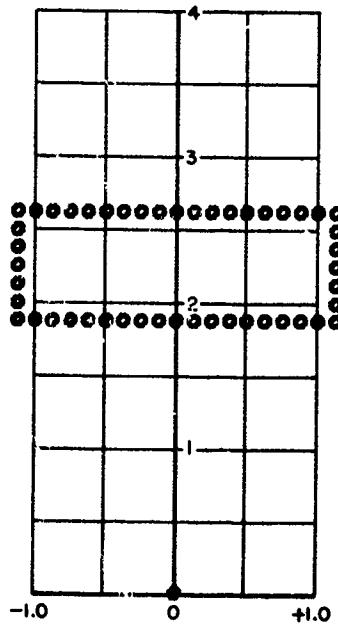
DISTANCE ~ WAVELENGTHS

4-15

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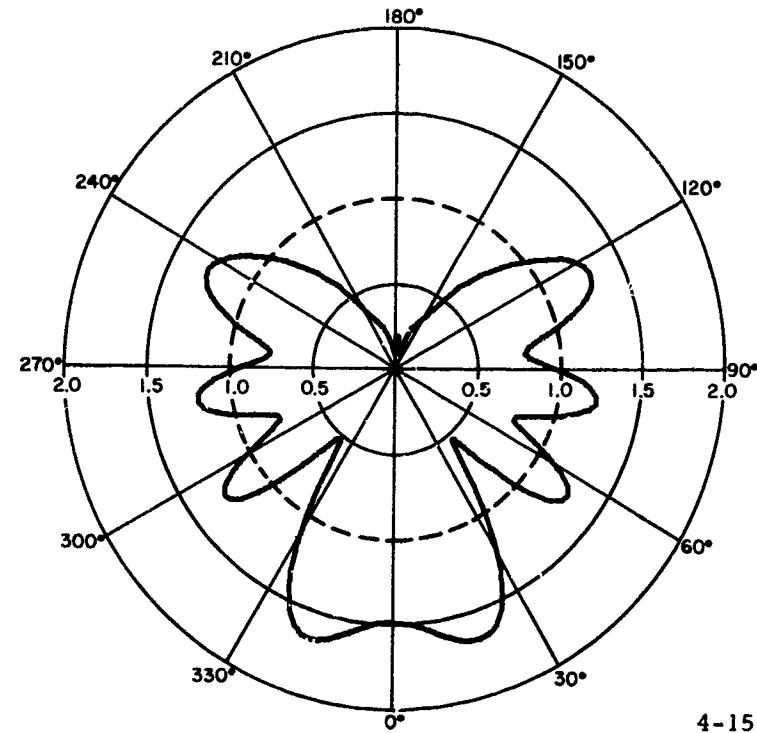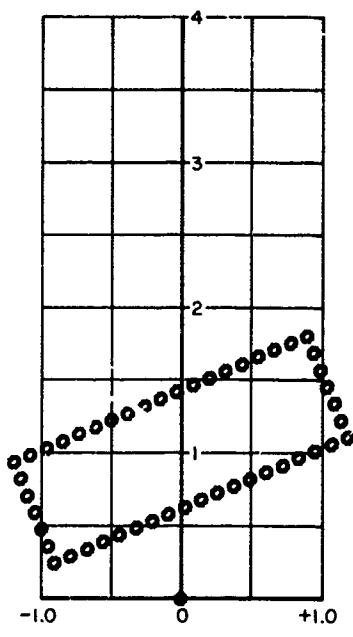
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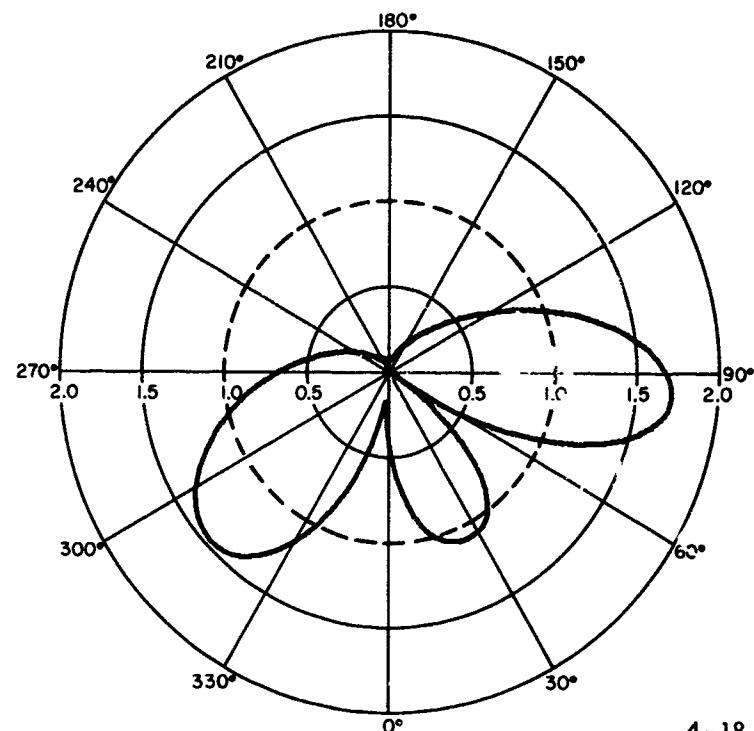
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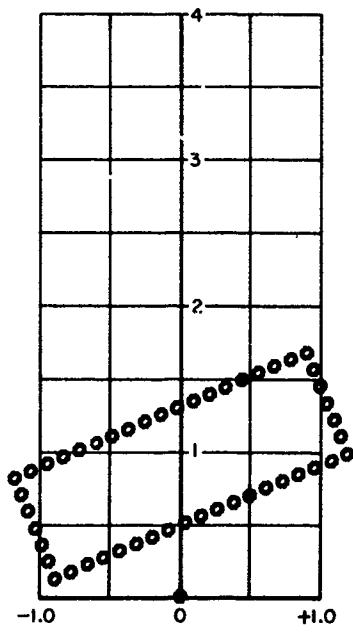
DISTANCE ~ WAVELENGTHS

4-17

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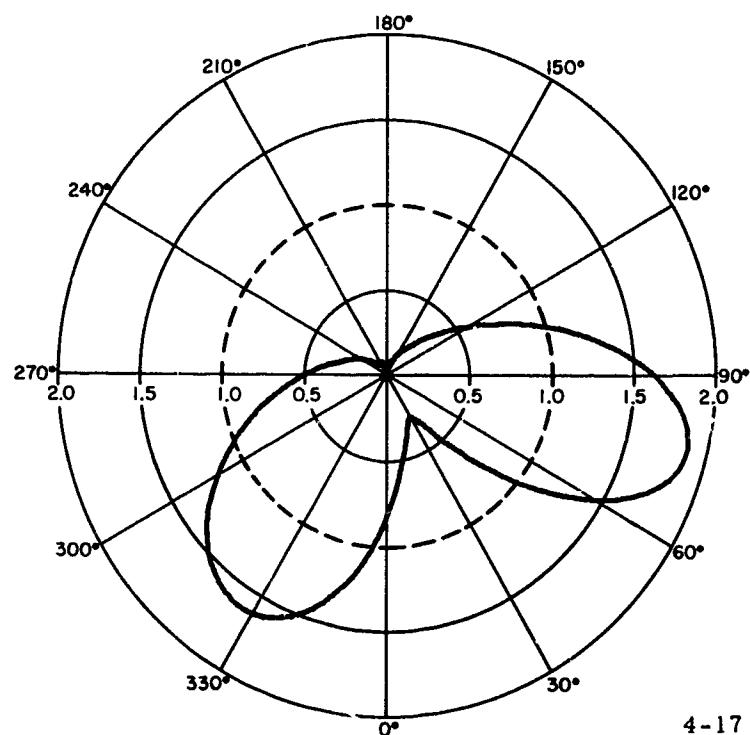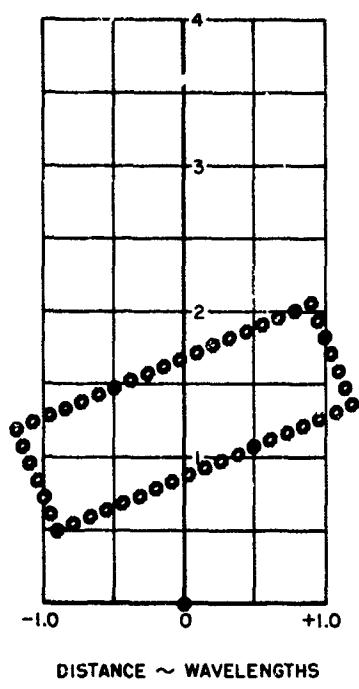
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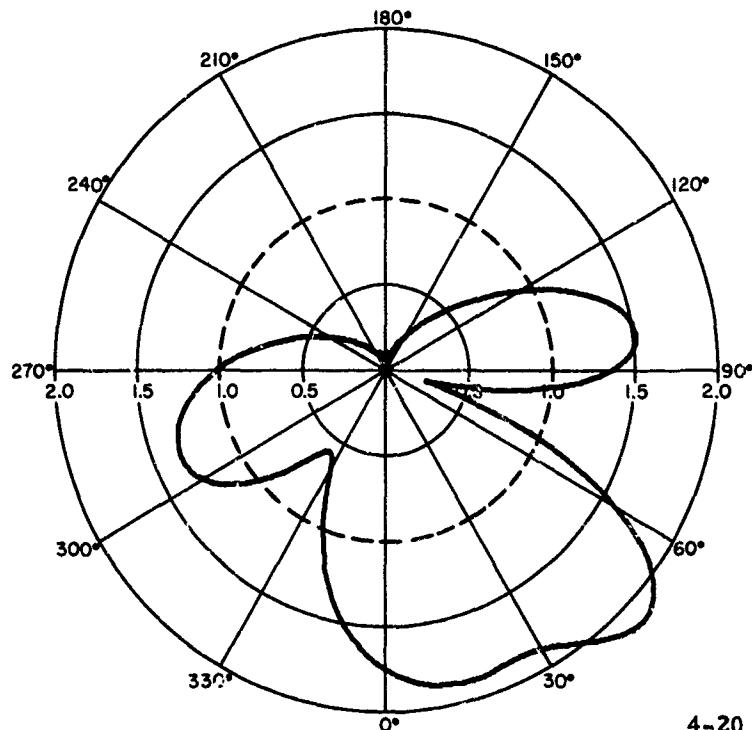
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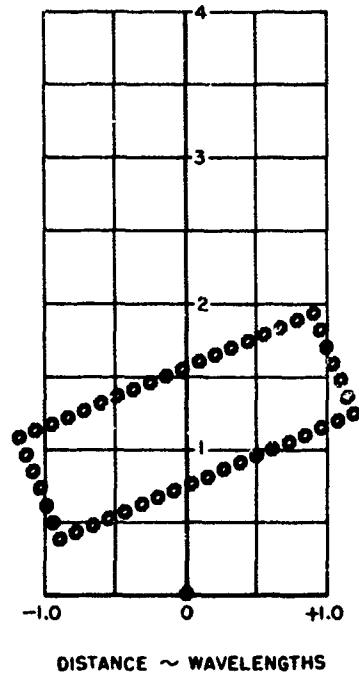
DISTANCE ~ WAVELENGTHS

4-19

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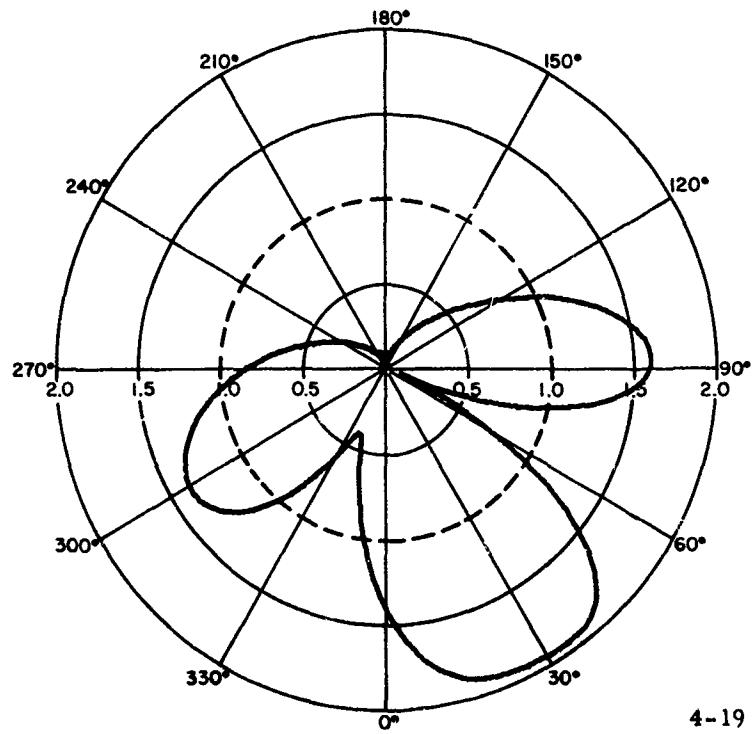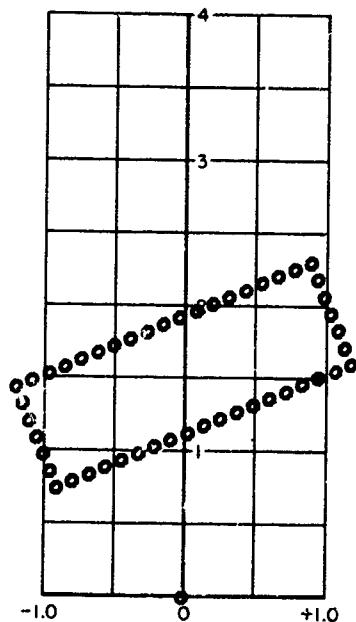
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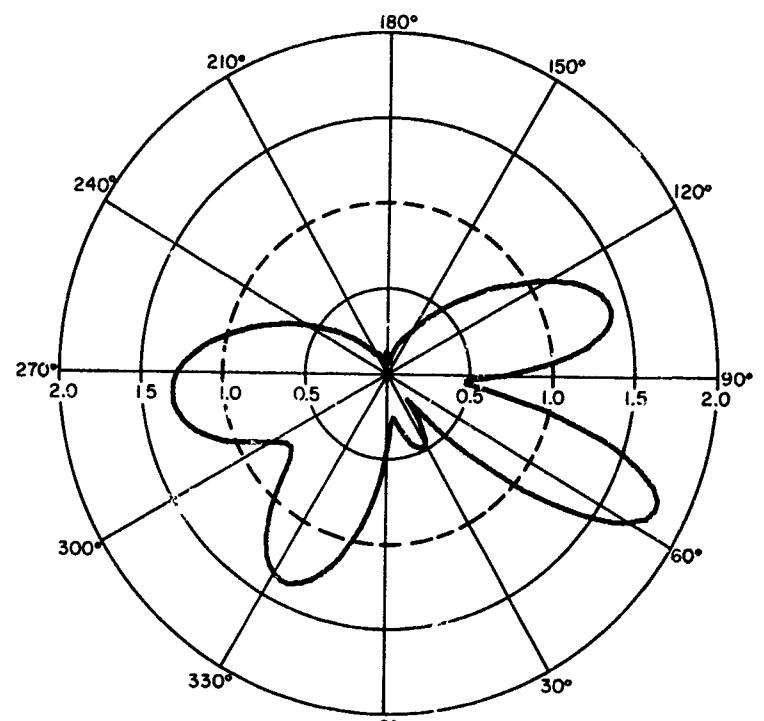
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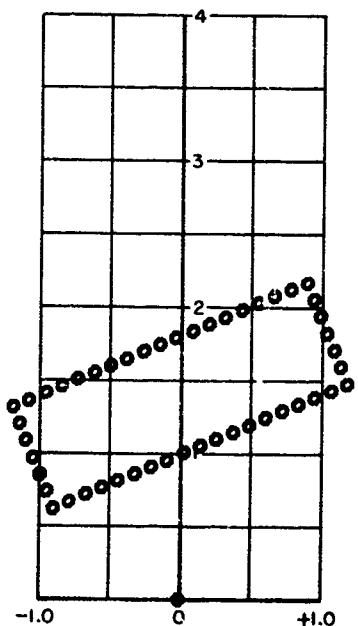
DISTANCE ~ WAVELENGTHS

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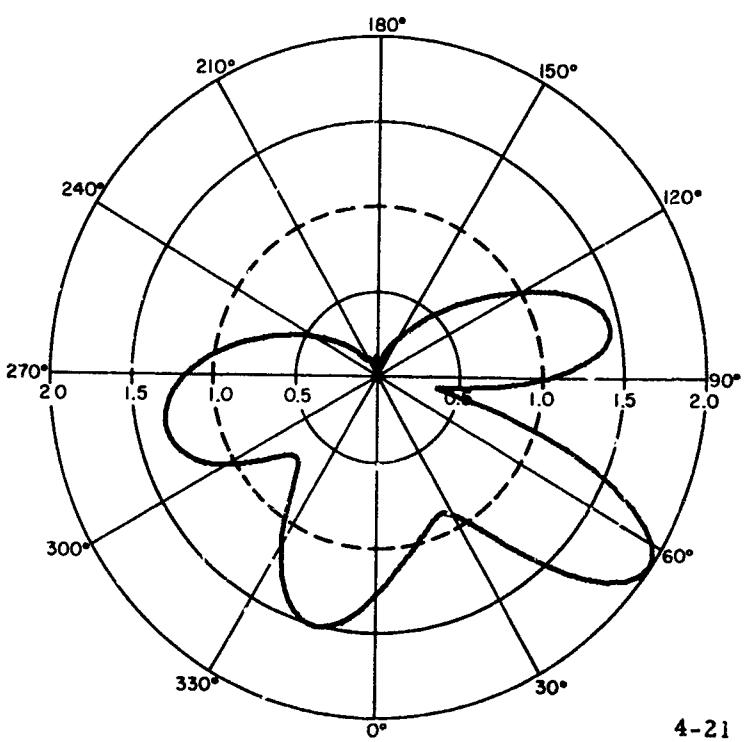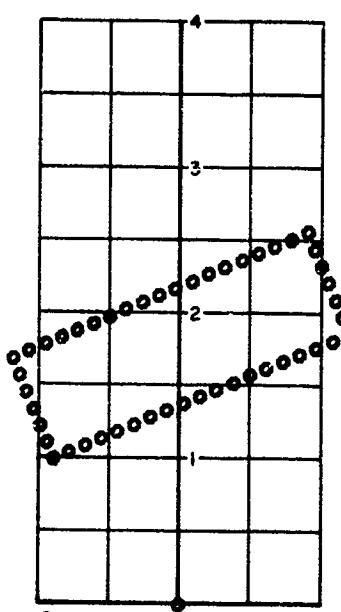
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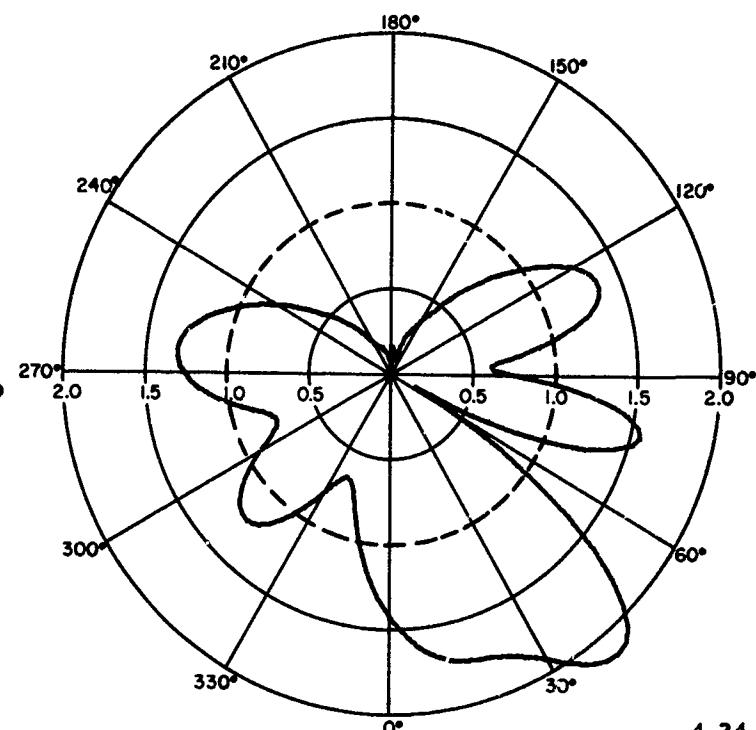
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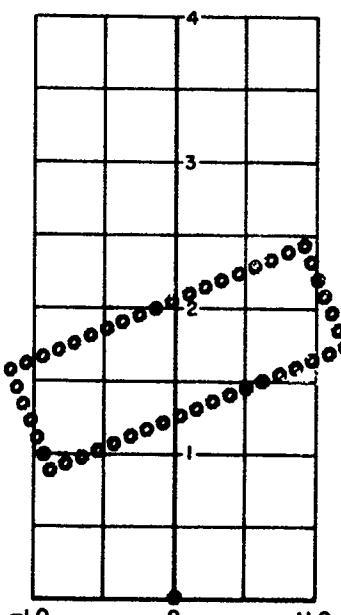
DISTANCE ~ WAVELENGTHS

4-23

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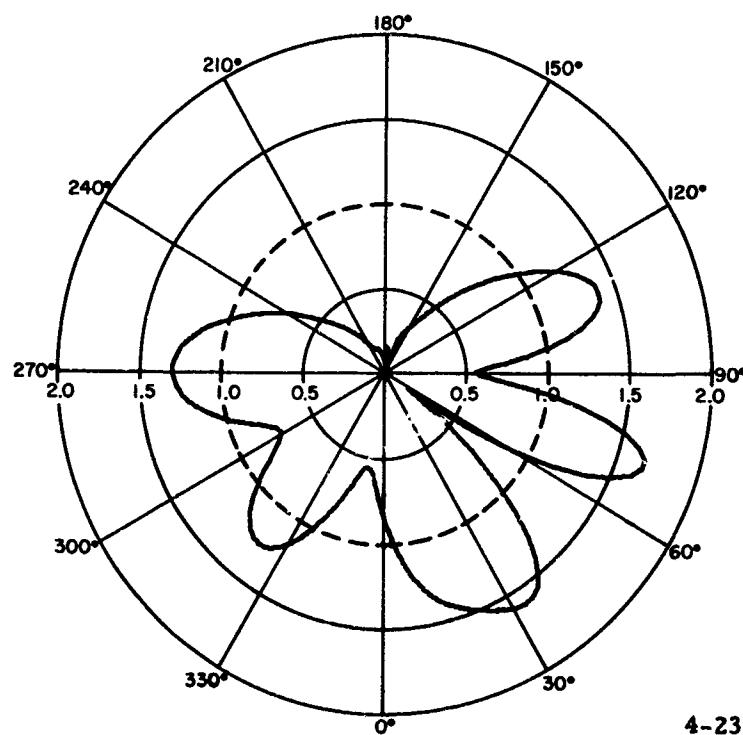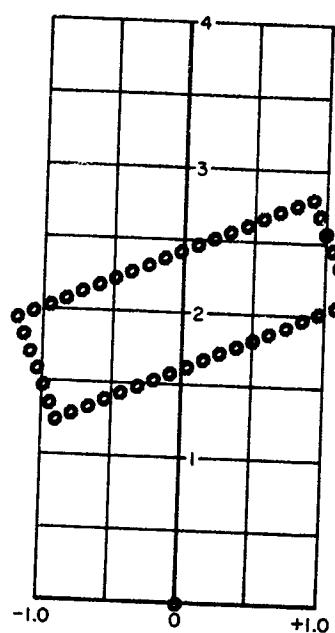
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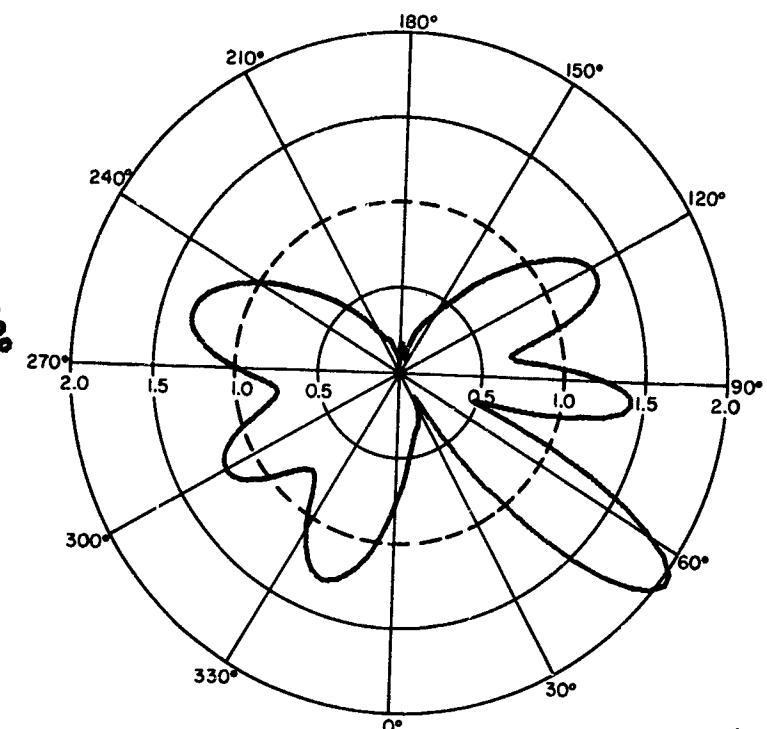
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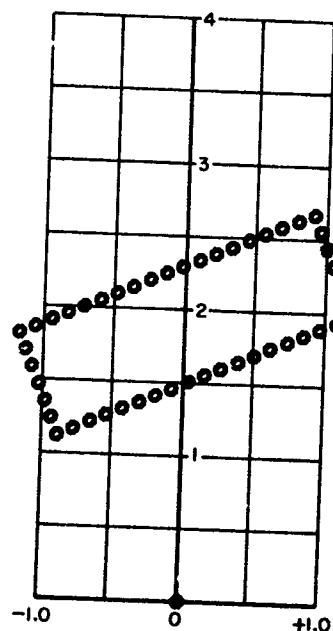
DISTANCE ~ WAVELENGTHS

4-25

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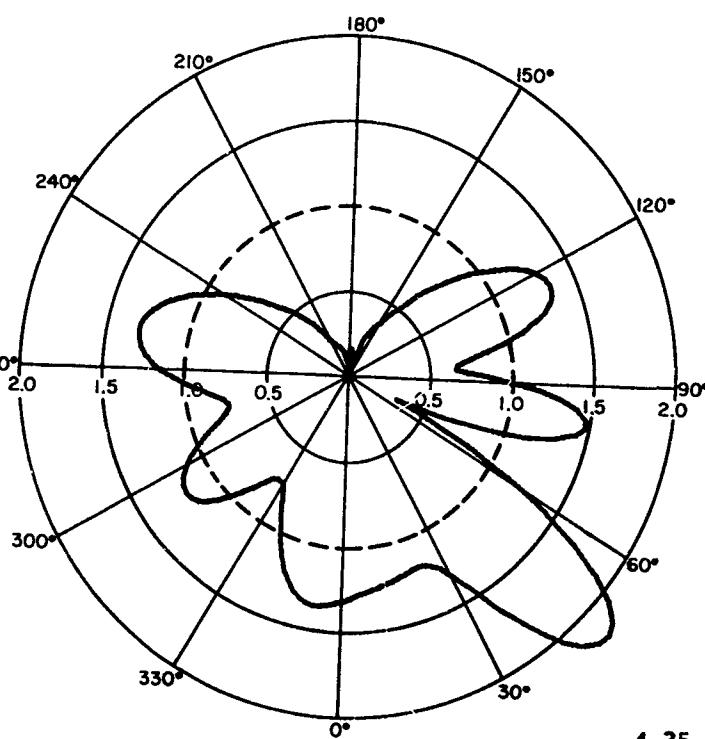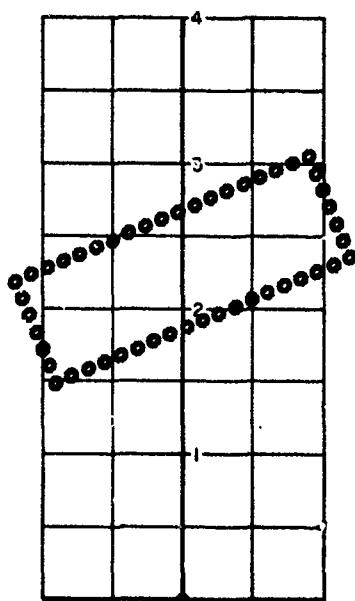
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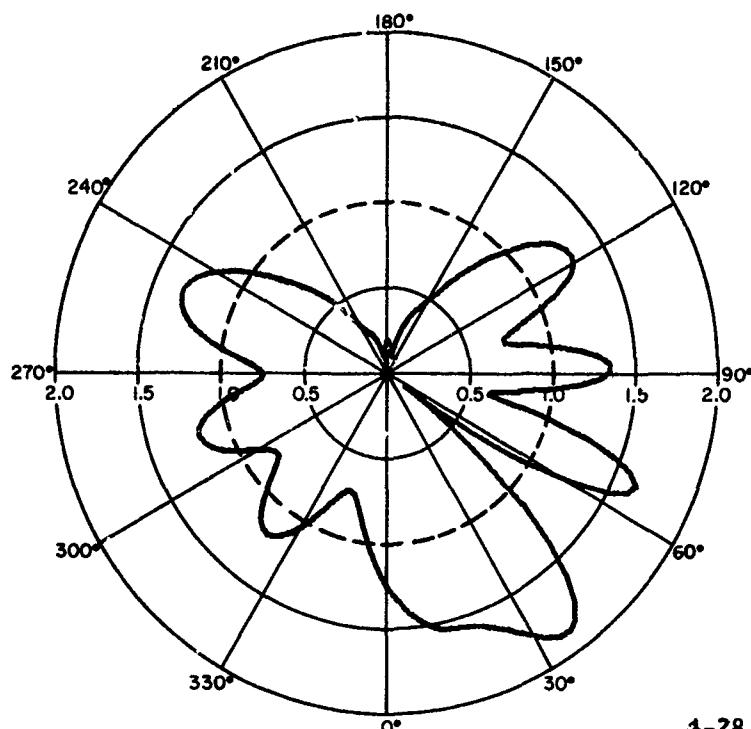
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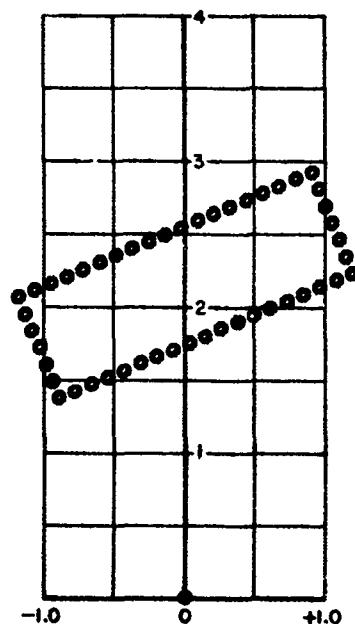
DISTANCE ~ WAVELENGTHS

4-27

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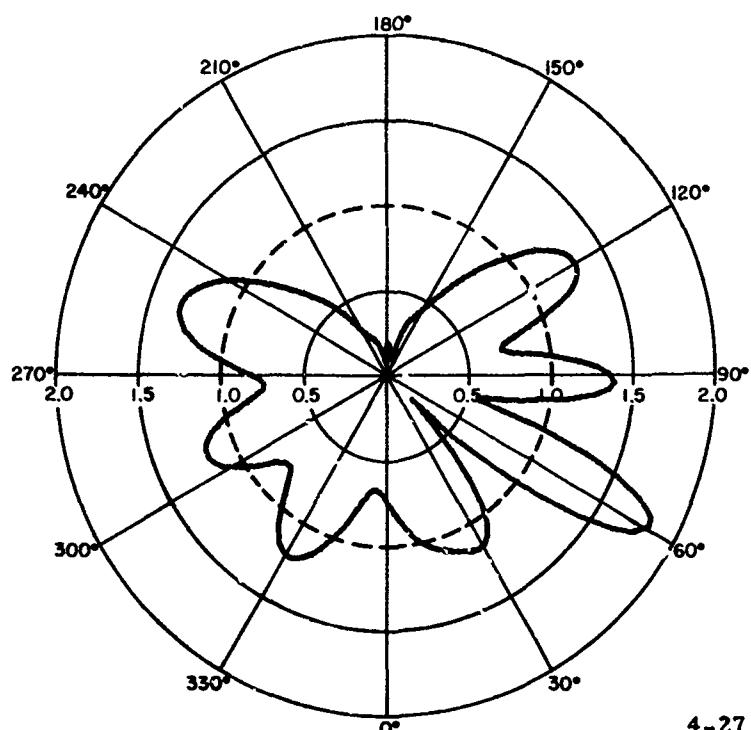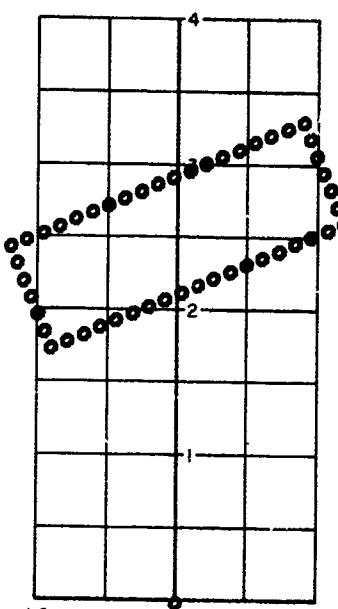
DISTANCE ~ WAVELENGTHS

4-30

DISTANCE ~ WAVELENGTHS

4-29

135

DISTANCE ~ WAVELENGTHS

4-32

DISTANCE ~ WAVELENGTHS

4-31

136

DISTANCE ~ WAVELENGTHS

4-34

DISTANCE ~ WAVELENGTHS

4-33

137
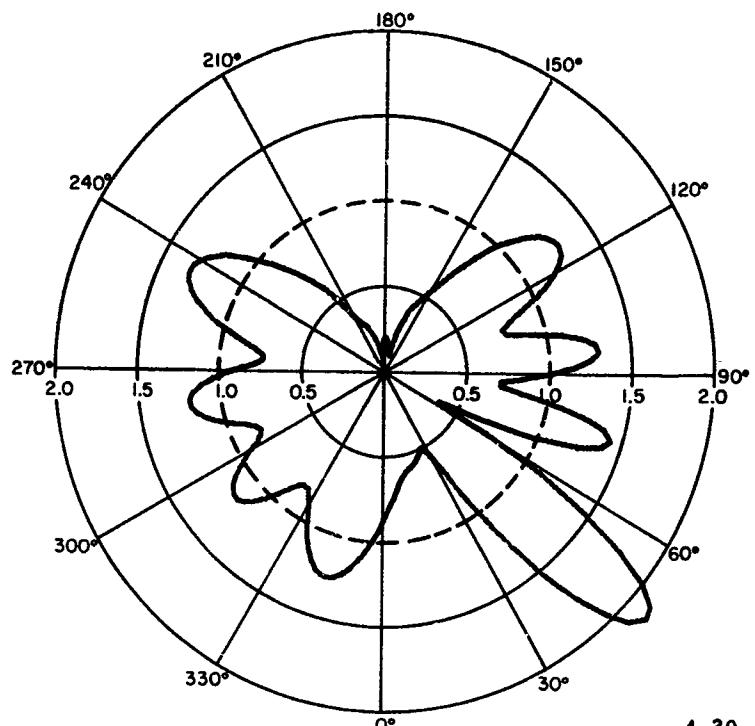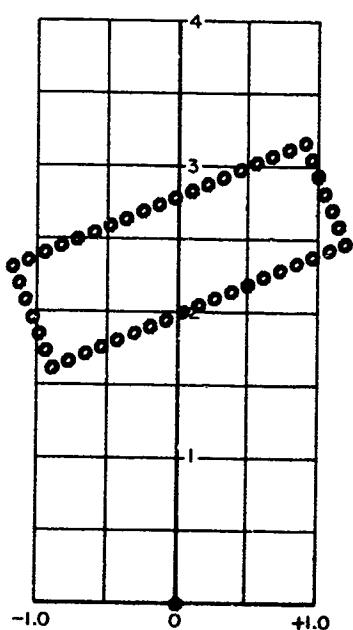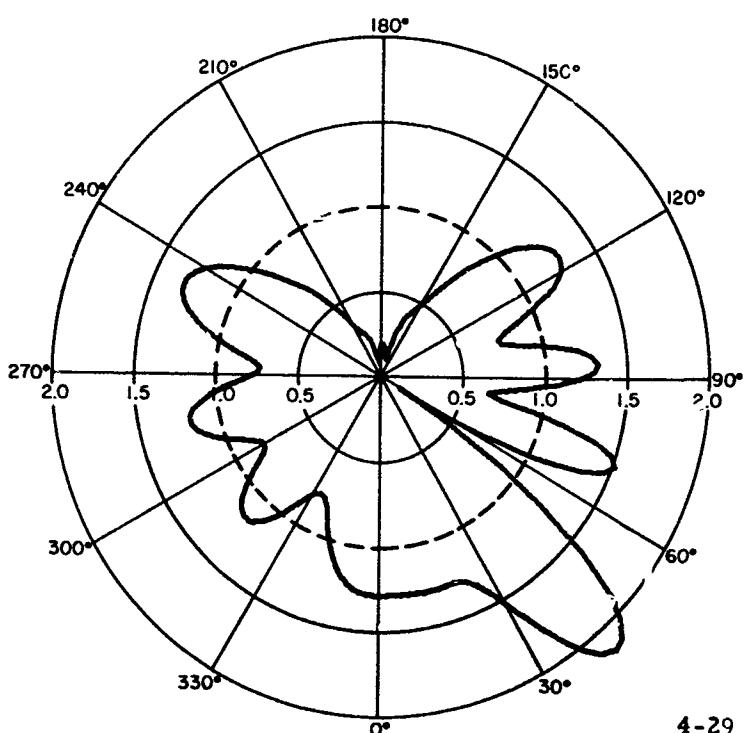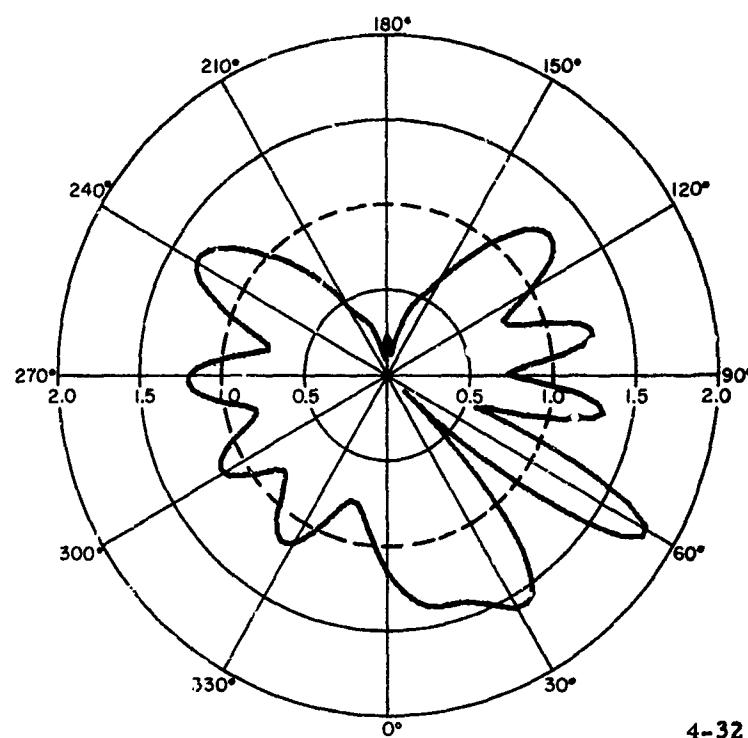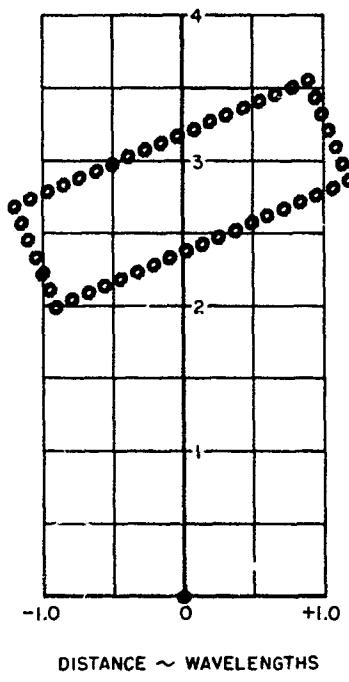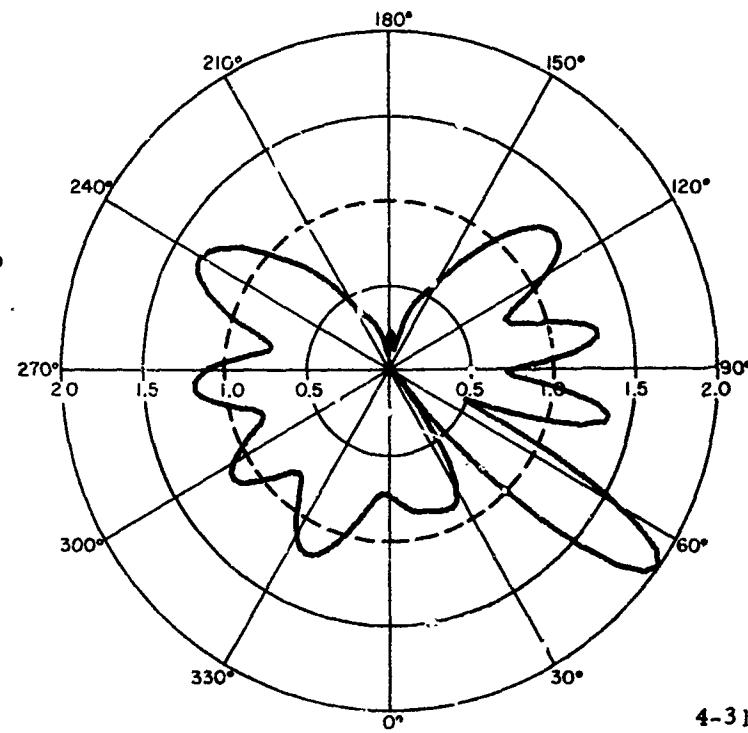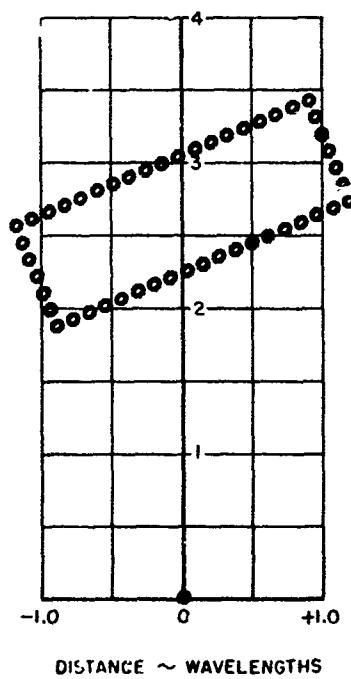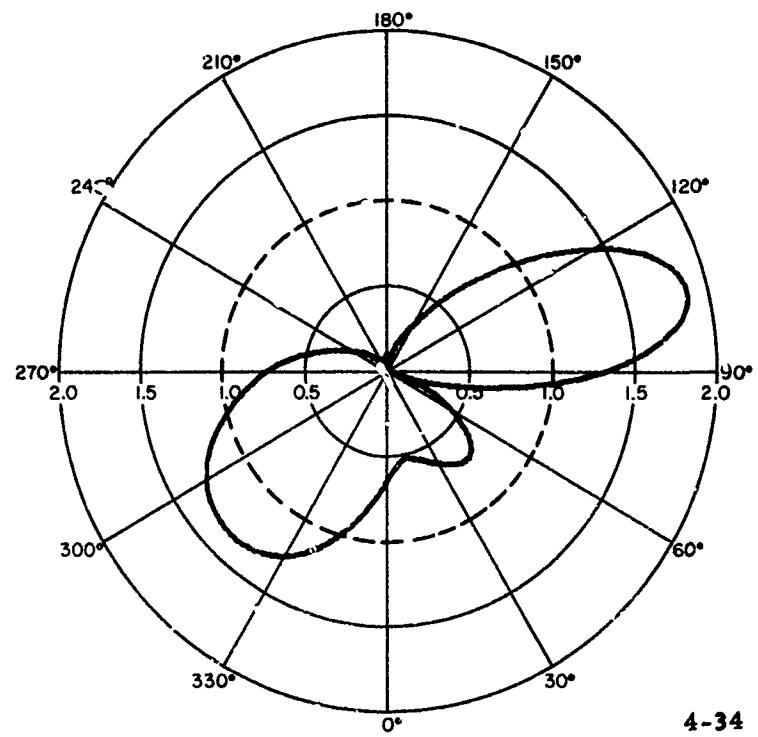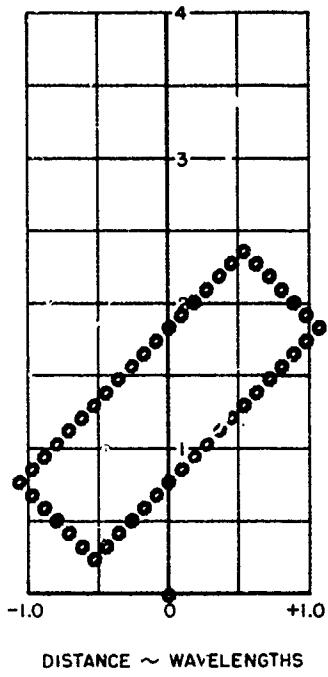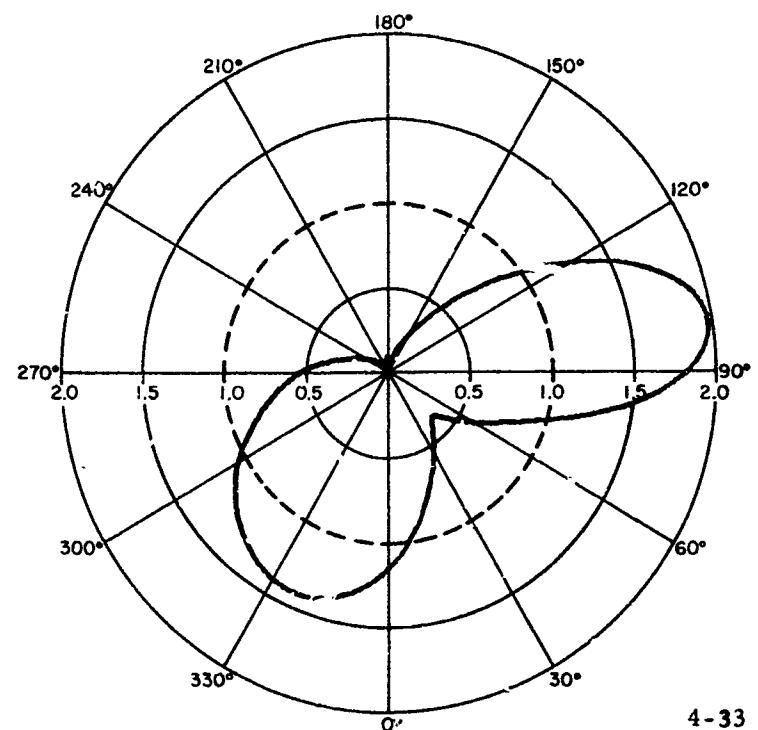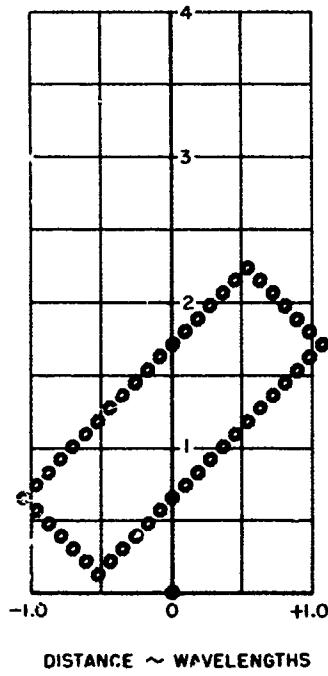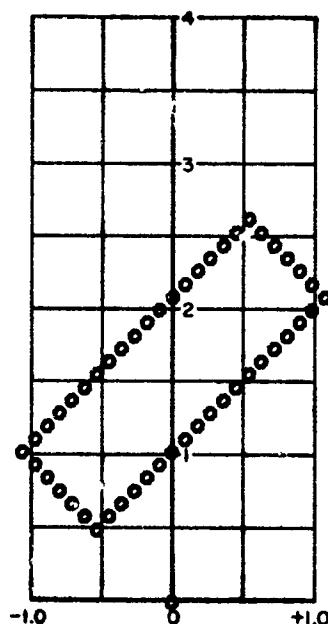
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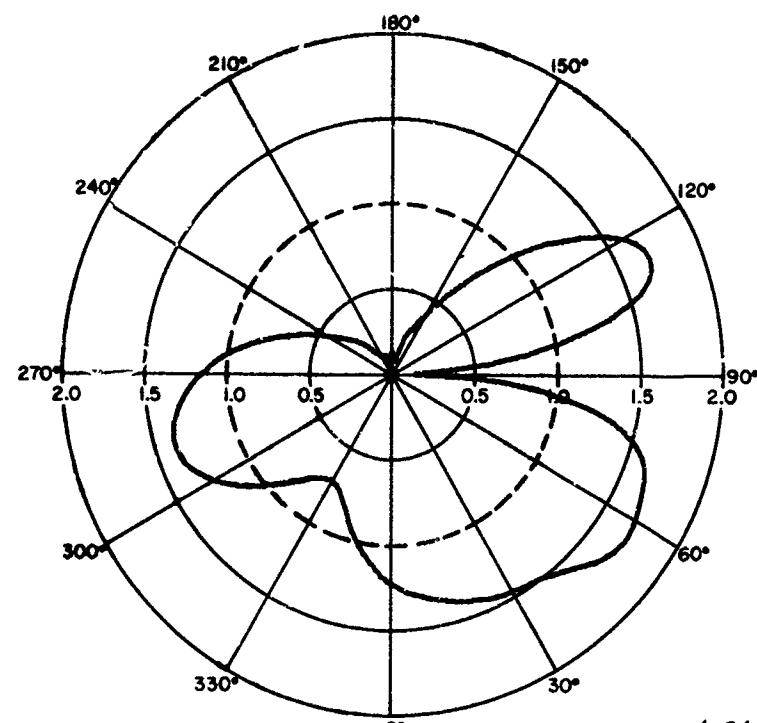
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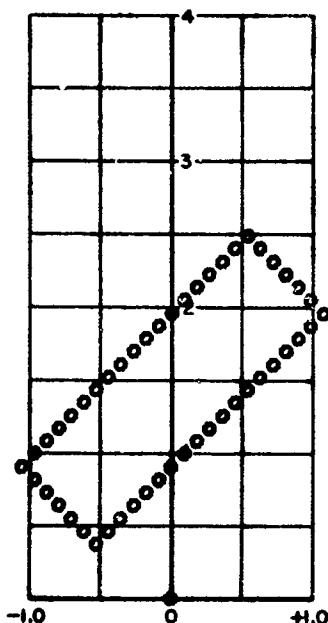
DISTANCE ~ WAVELENGTHS

4-35

138
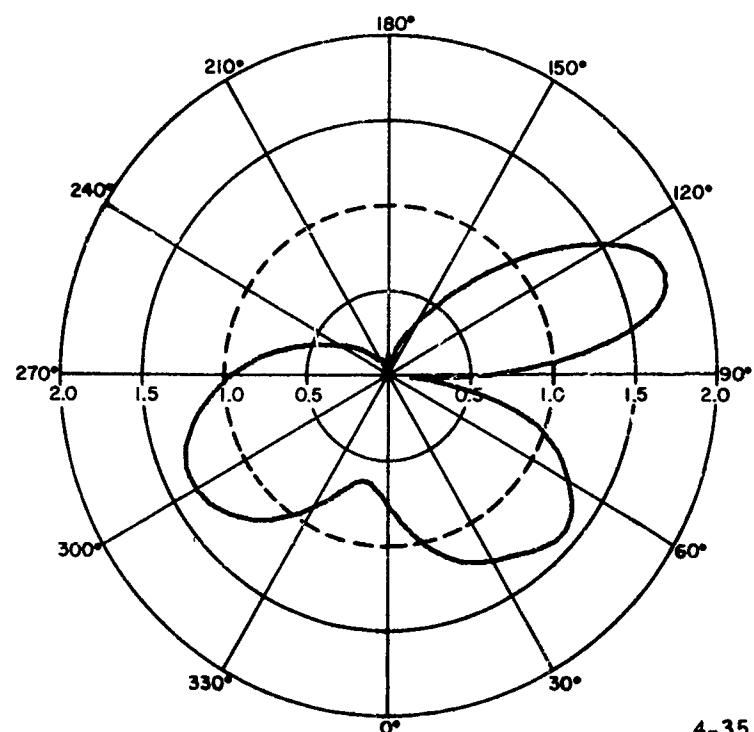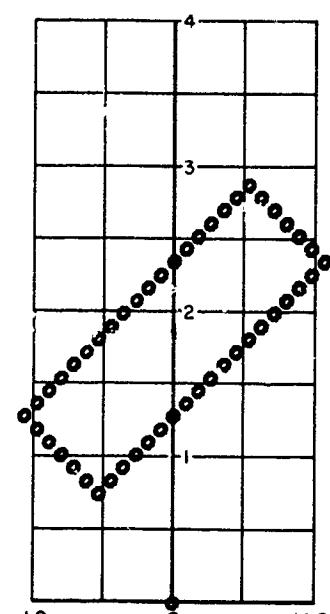
DISTANCE ~ WAVELENGTHS

4-38

DISTANCE ~ WAVELENGTHS

4-37

139

DISTANCE ~ WAVELENGTHS

4-40

DISTANCE ~ WAVELENGTHS

4-39

140
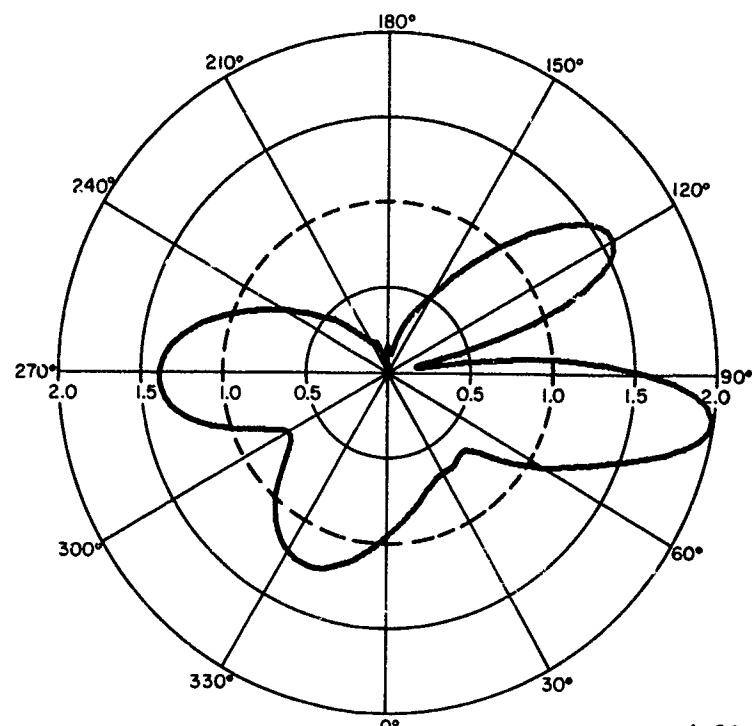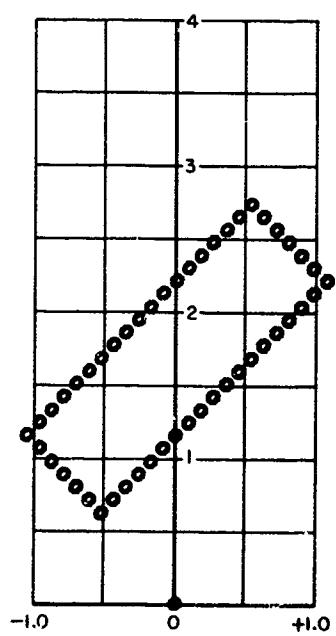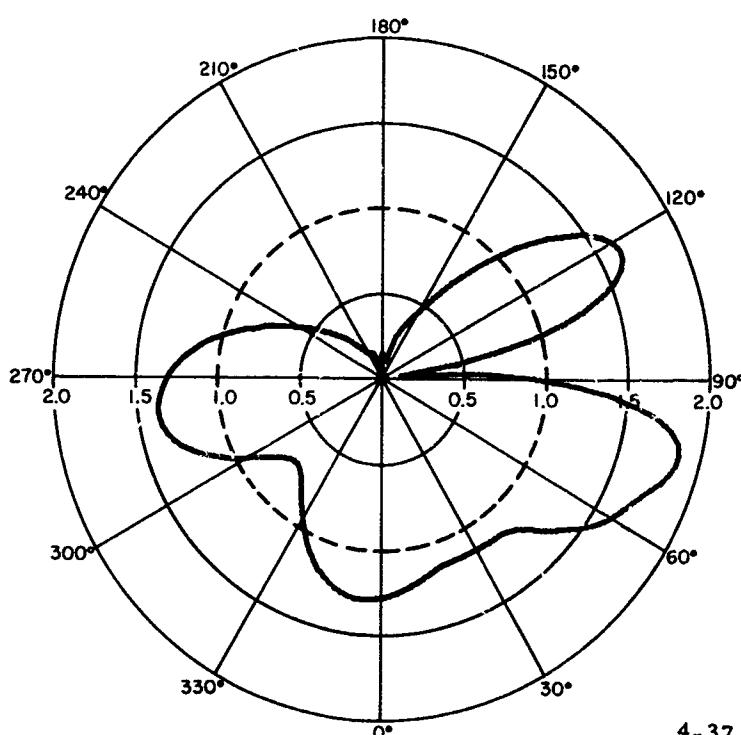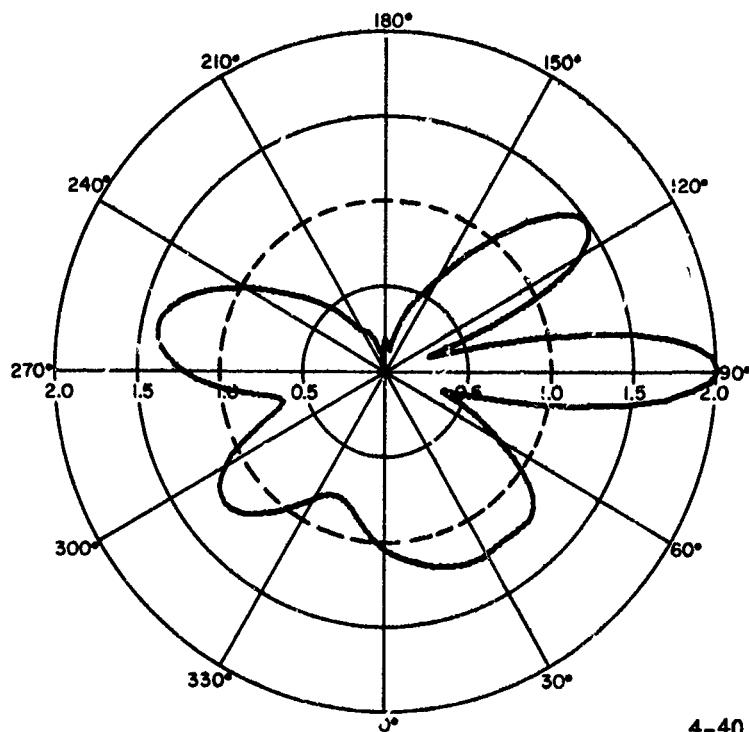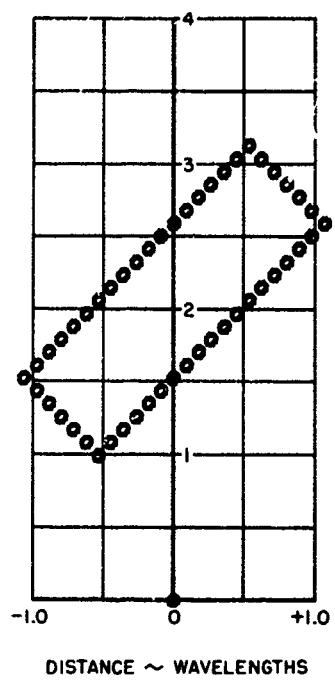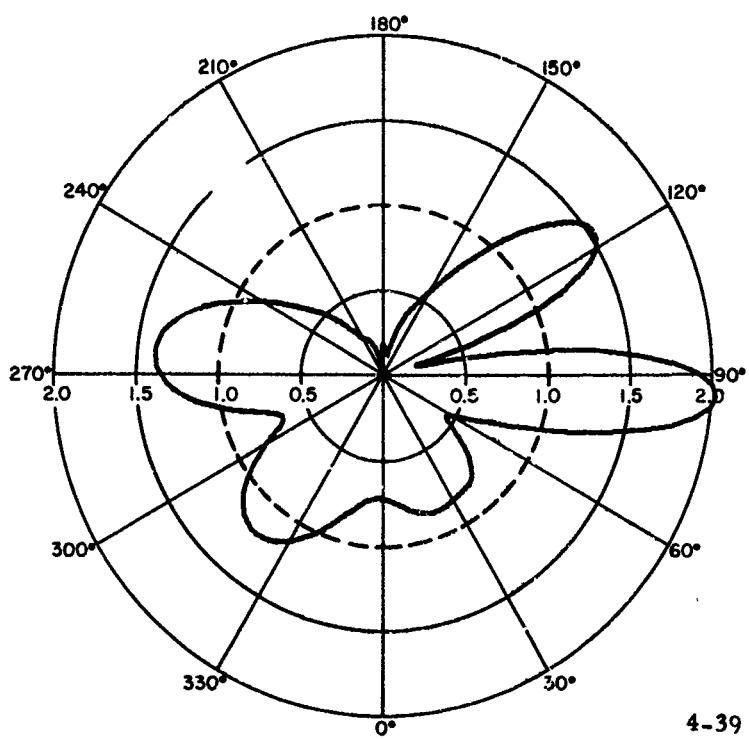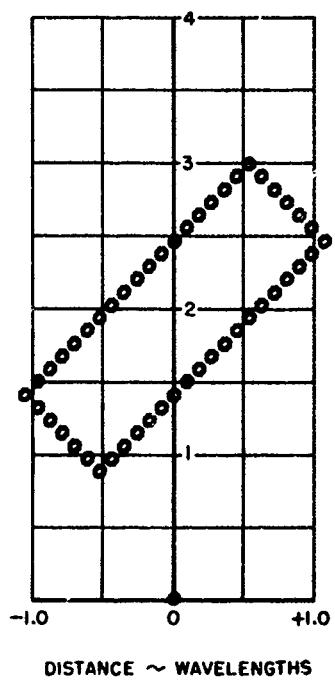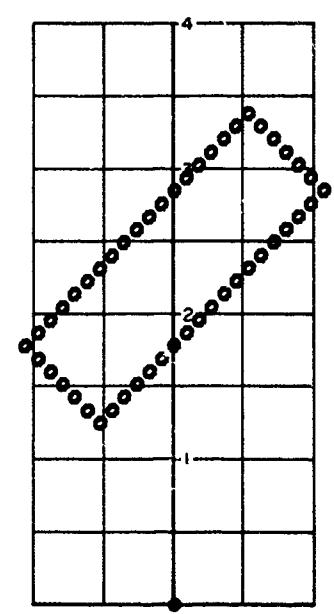
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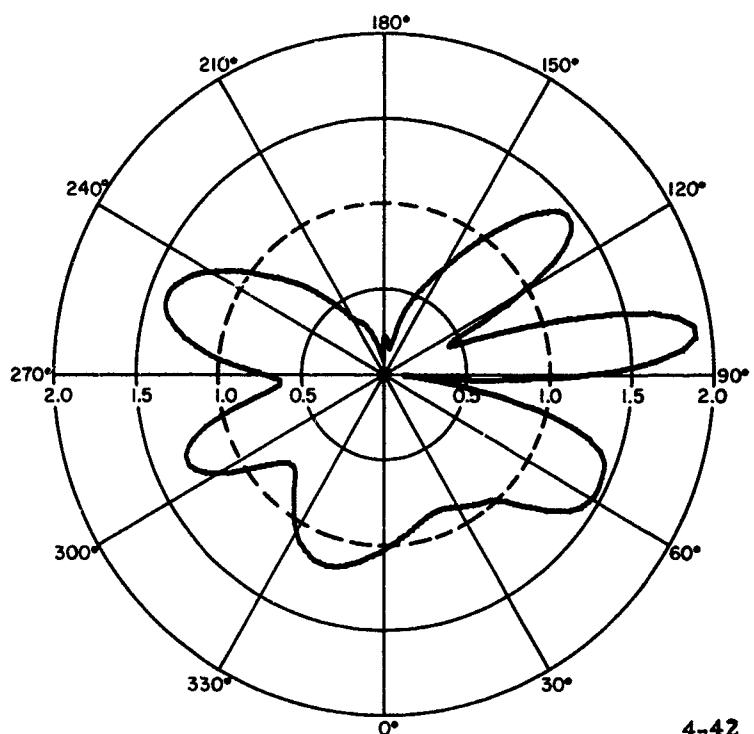
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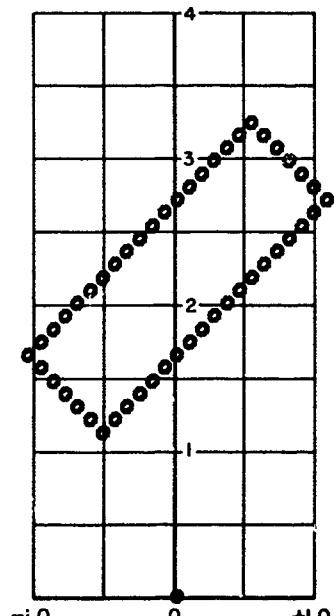
DISTANCE ~ WAVELENGTHS

4-41

141
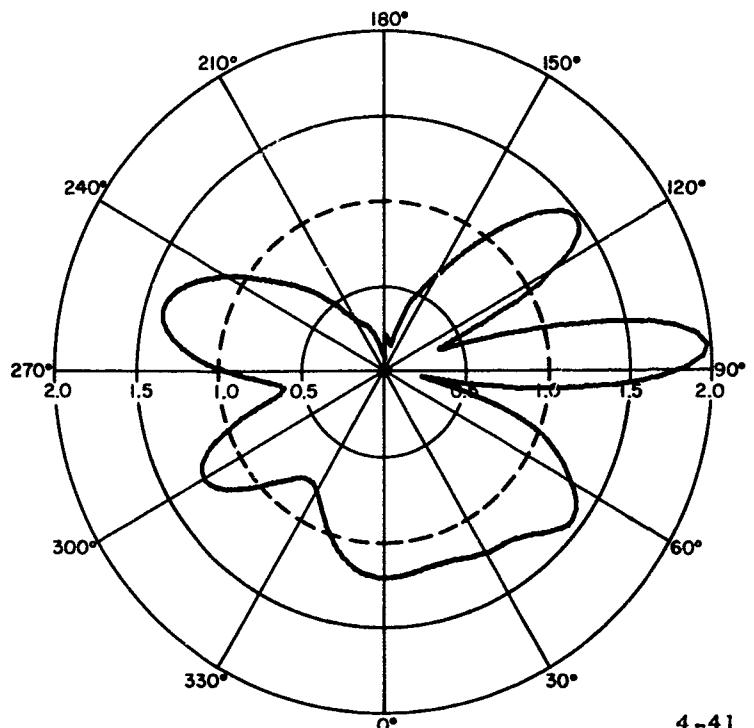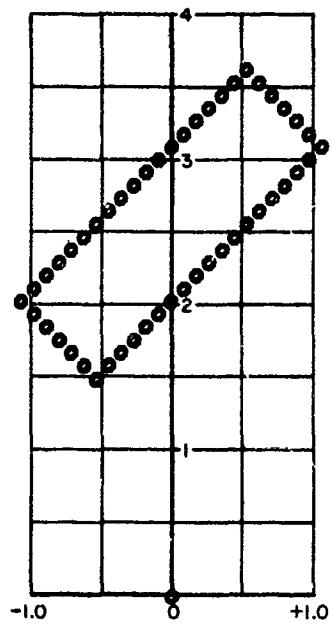
DISTANCE ~ WAVELENGTHS

4-44

DISTANCE ~ WAVELENGTHS

4-43

142

DISTANCE ~ WAVELENGTHS

4-45

DISTANCE ~ WAVELENGTHS

4-45

143

DISTANCE ~ WAVELENGTHS

4-48

DISTANCE ~ WAVELENGTHS

4-47

144
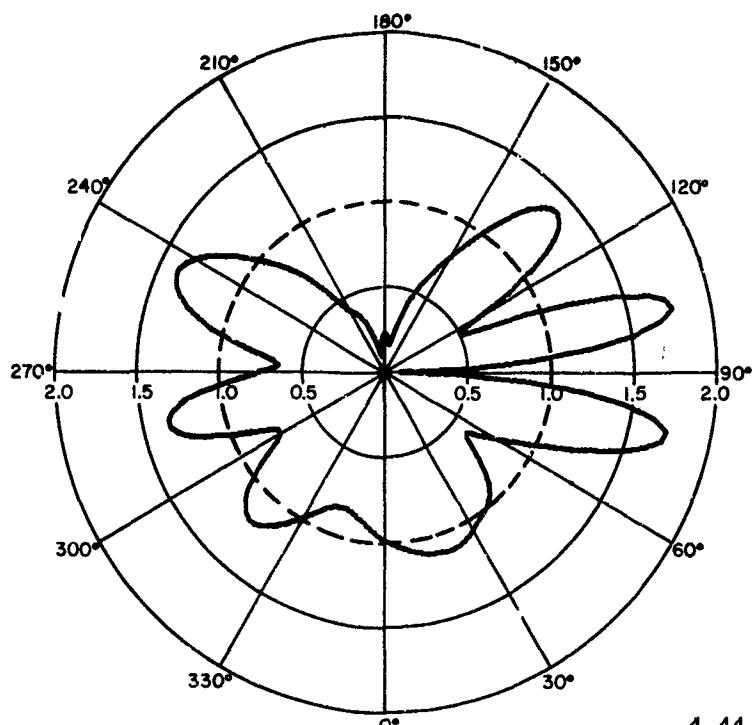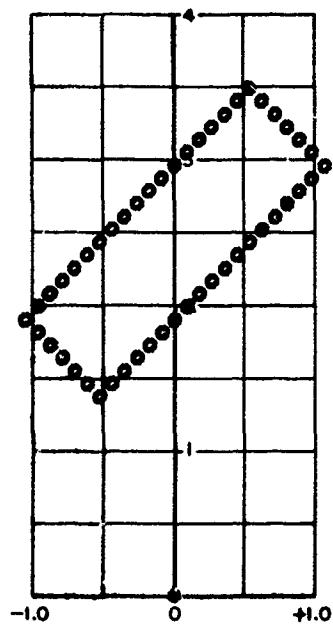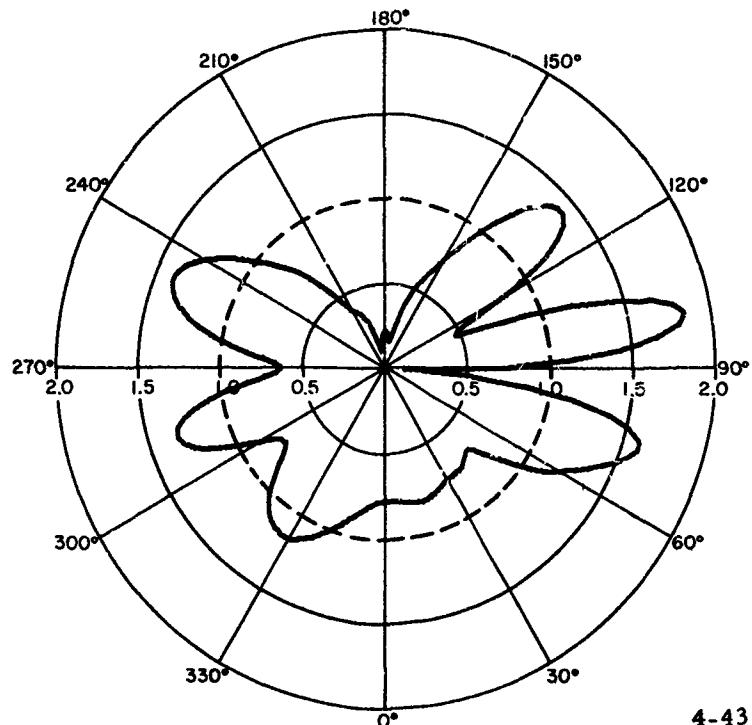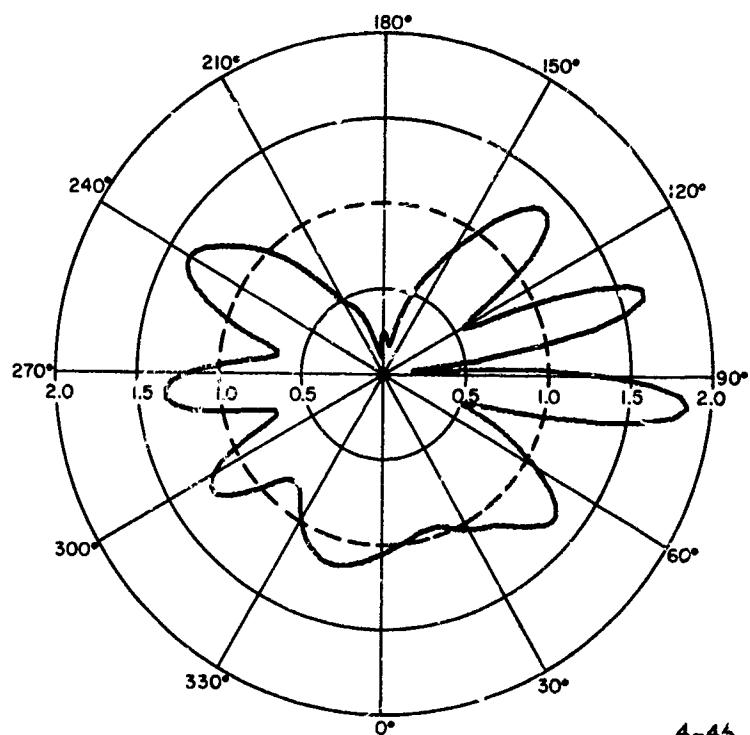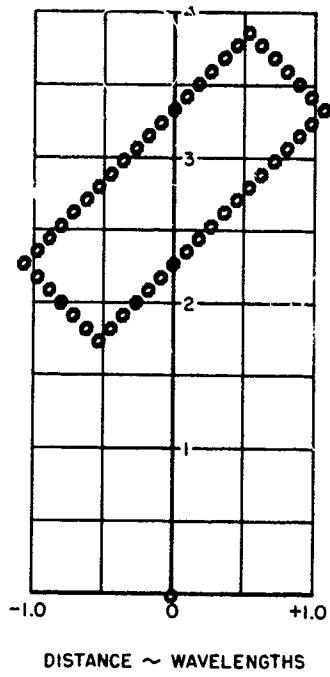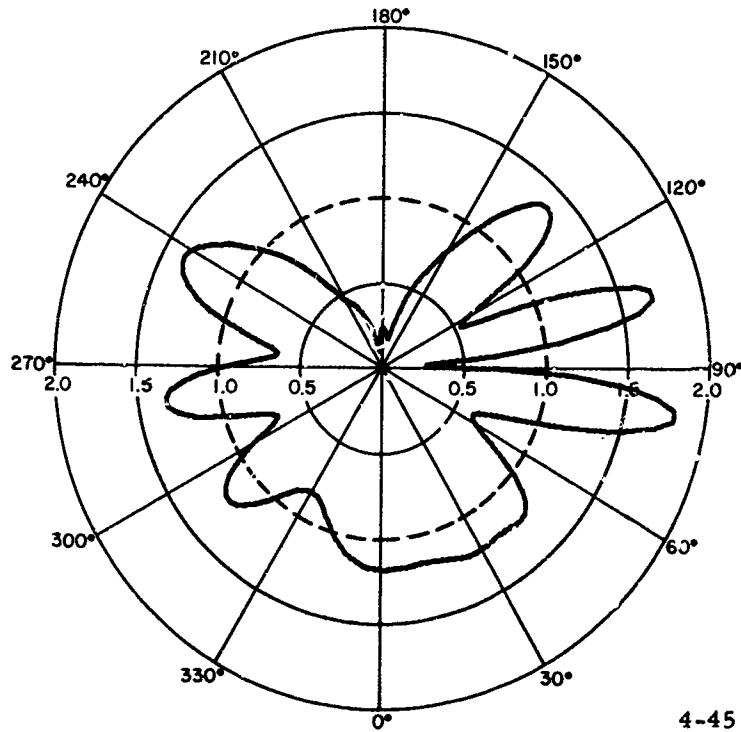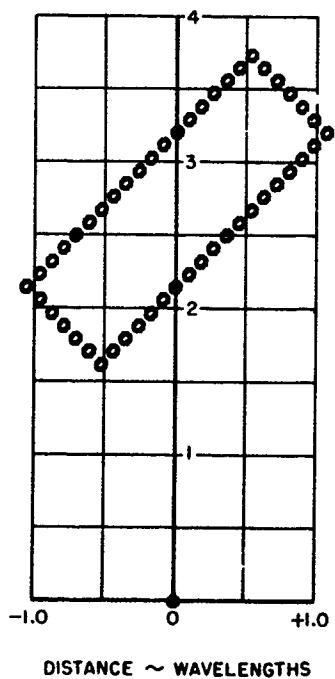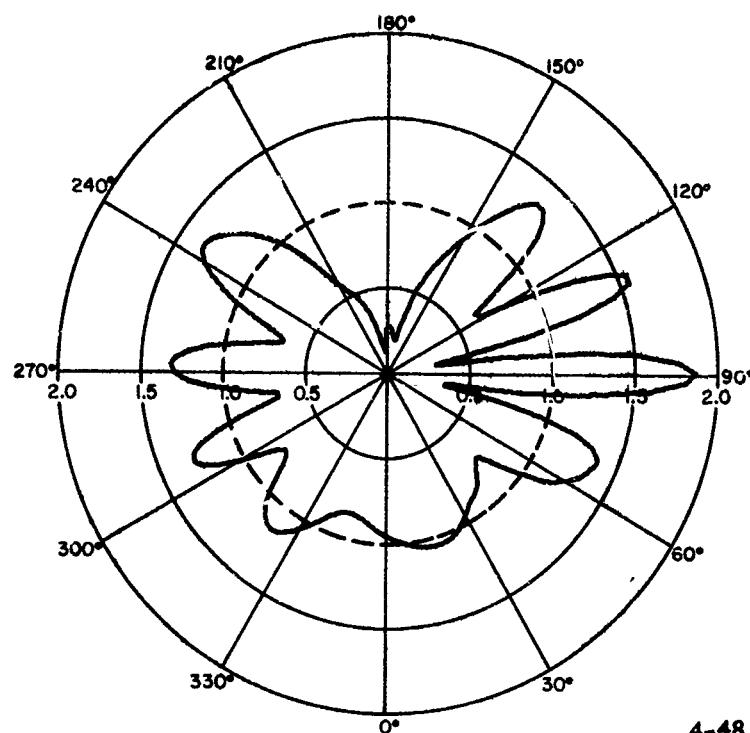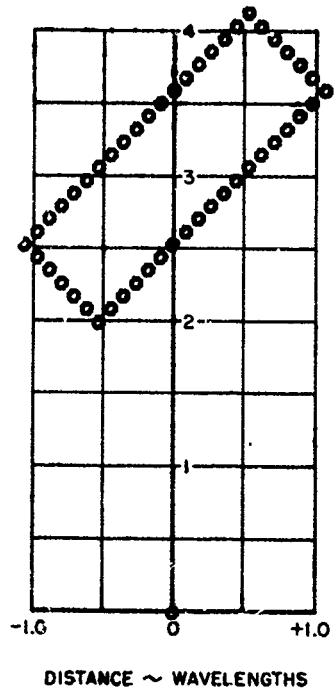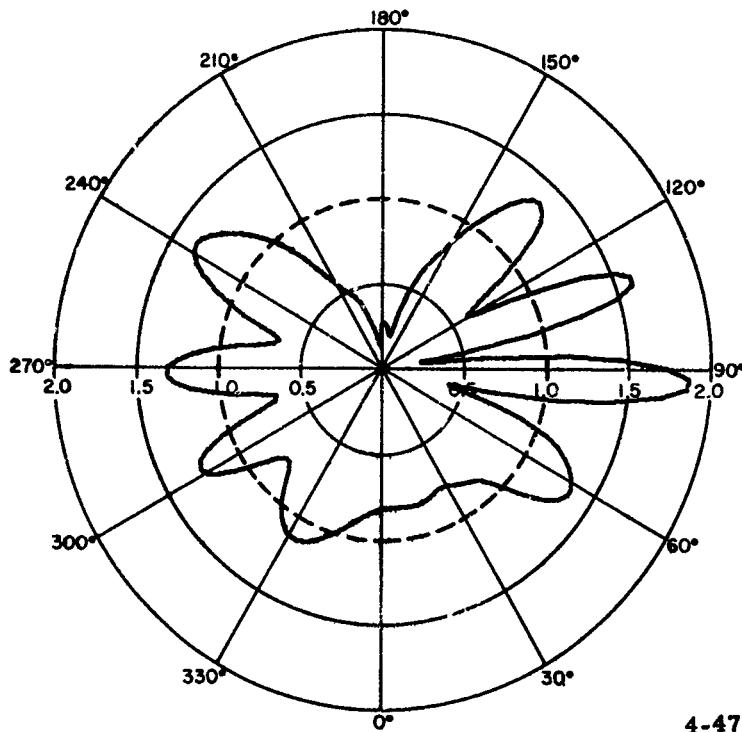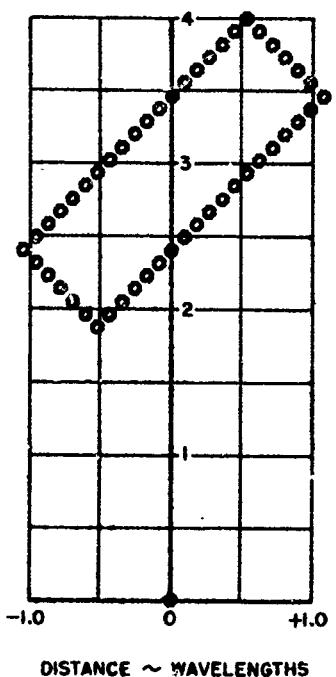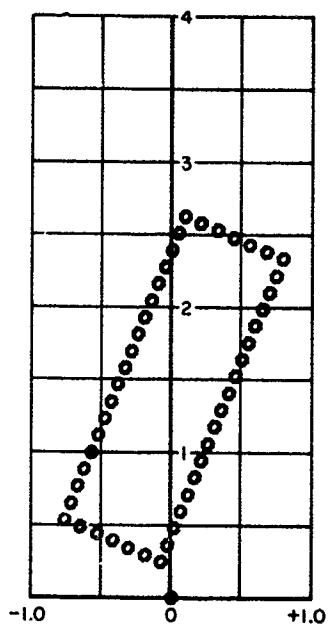
DISTANCE ~ WAVELENGTHS

4-50

DISTANCE ~ WAVELENGTHS

4-49

145

DISTANCE ~ WAVELENGTHS

4-52

DISTANCE ~ WAVELENGTHS

4-51

146
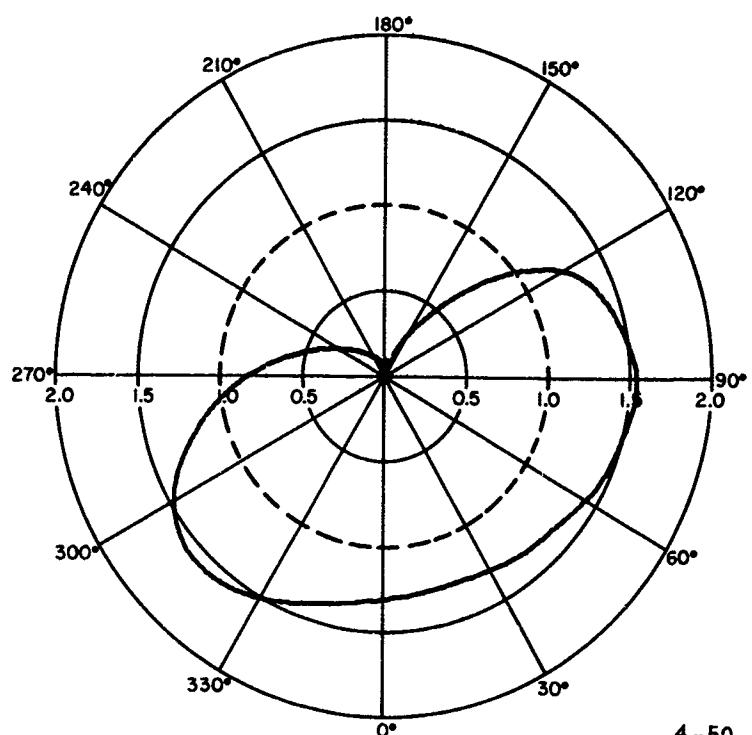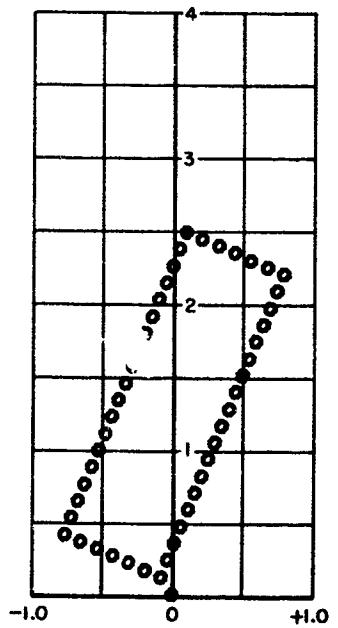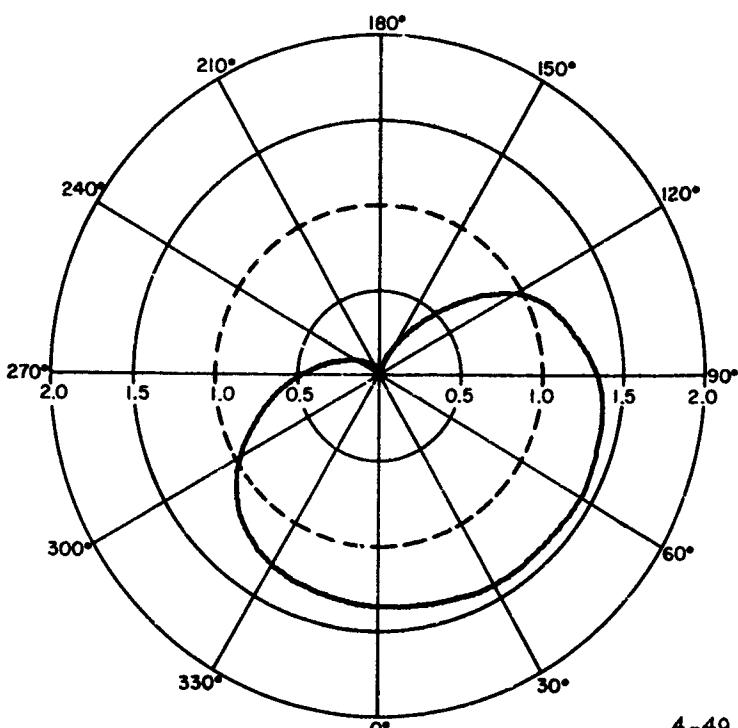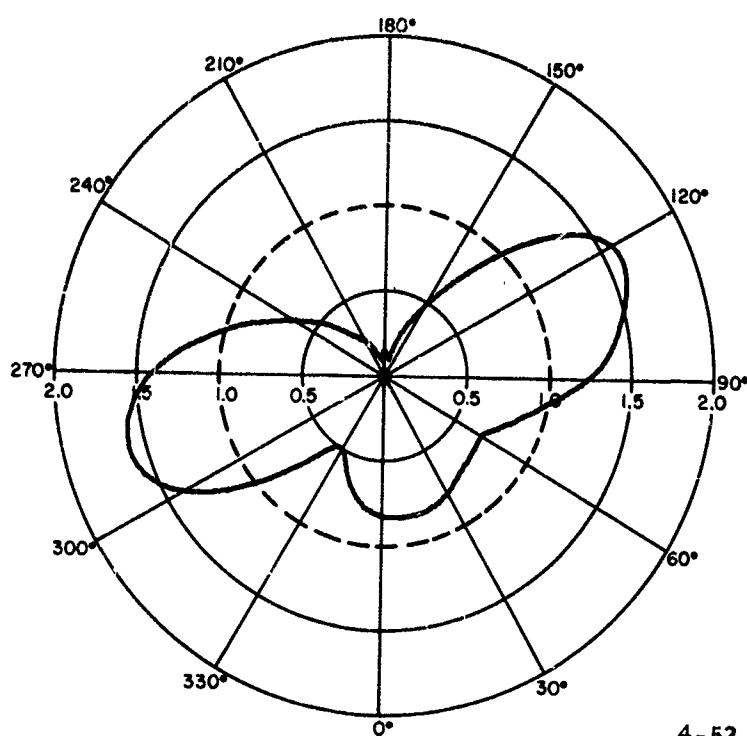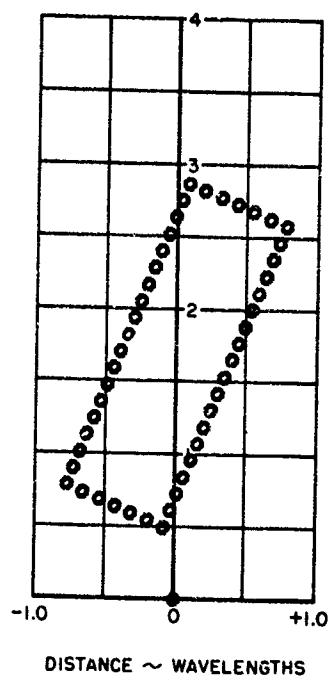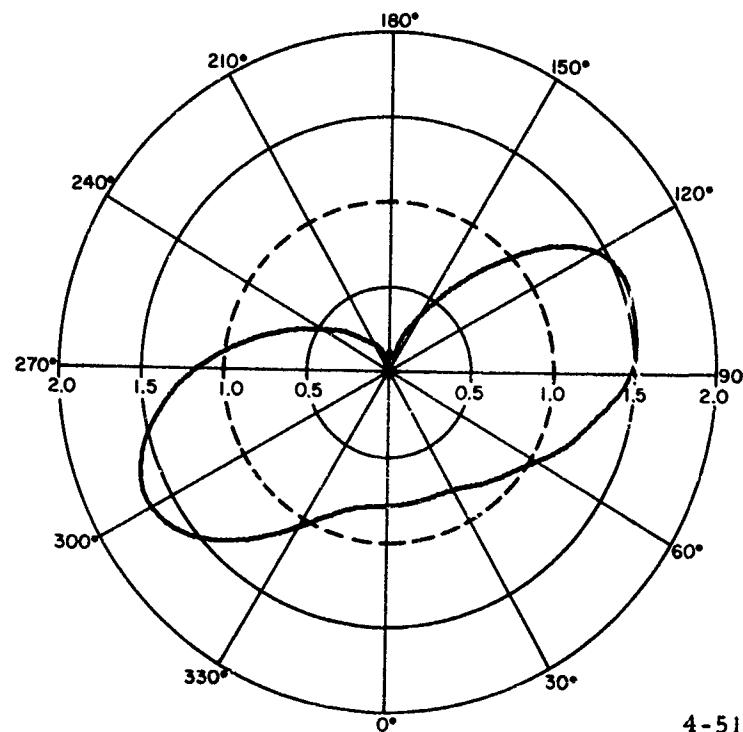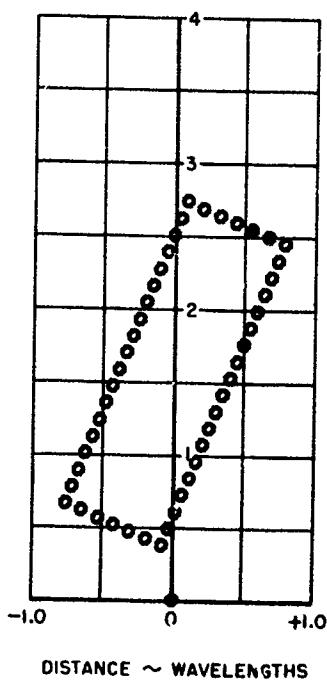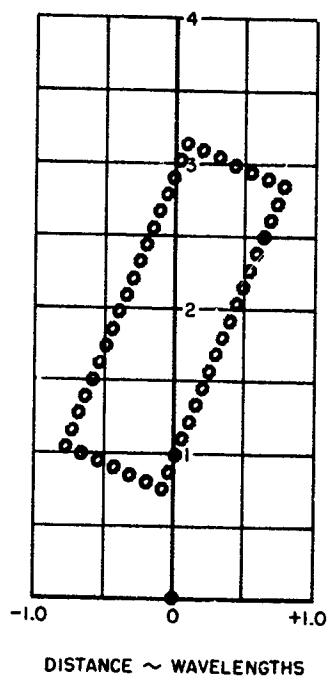
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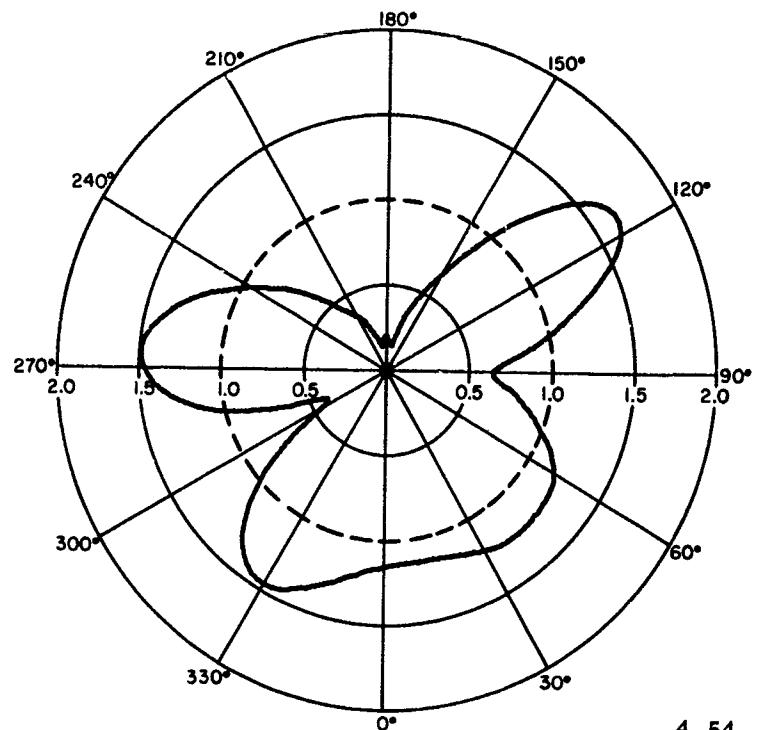
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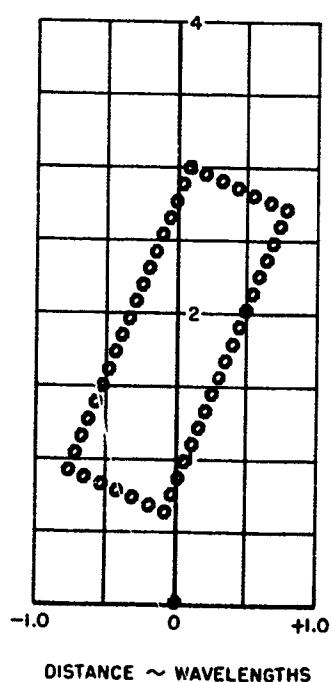
DISTANCE ~ WAVELENGTHS

4-53

147
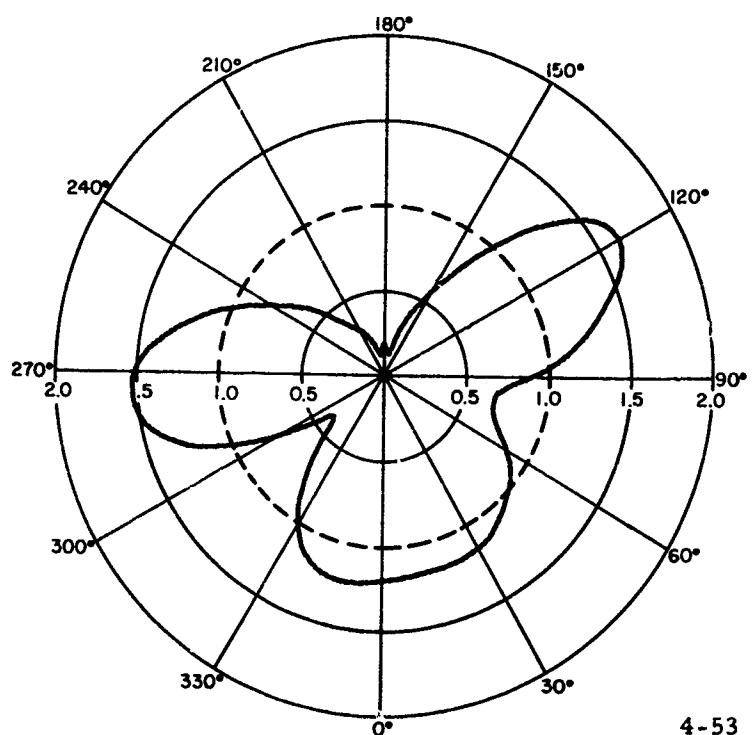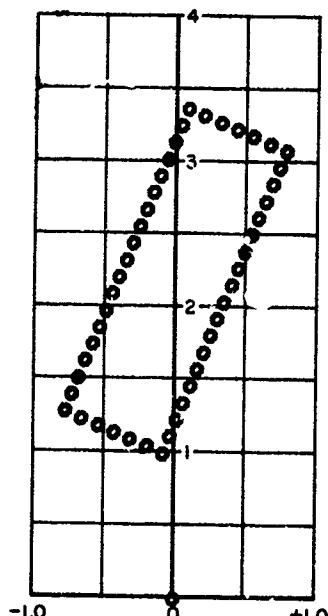
DISTANCE ~ WAVELENGTHS

4-56

DISTANCE ~ WAVELENGTHS

4-55

148

DISTANCE ~ WAVELENGTHS

4-58

DISTANCE ~ WAVELENGTHS

4-57

149

DISTANCE ~ WAVELENGTHS

4-60

DISTANCE ~ WAVELENGTHS

4-59

150
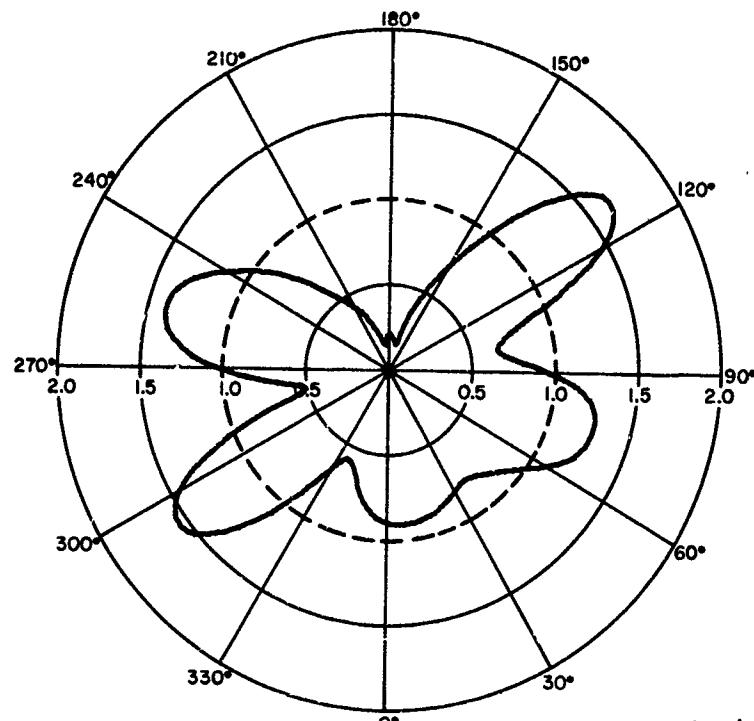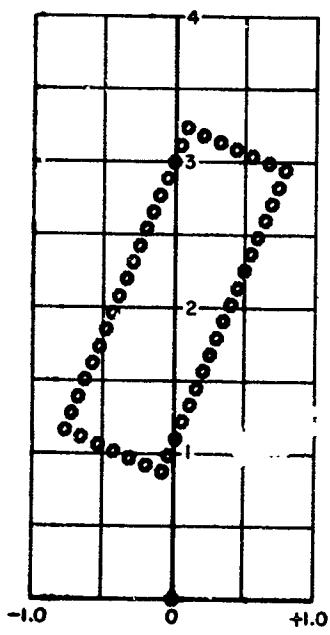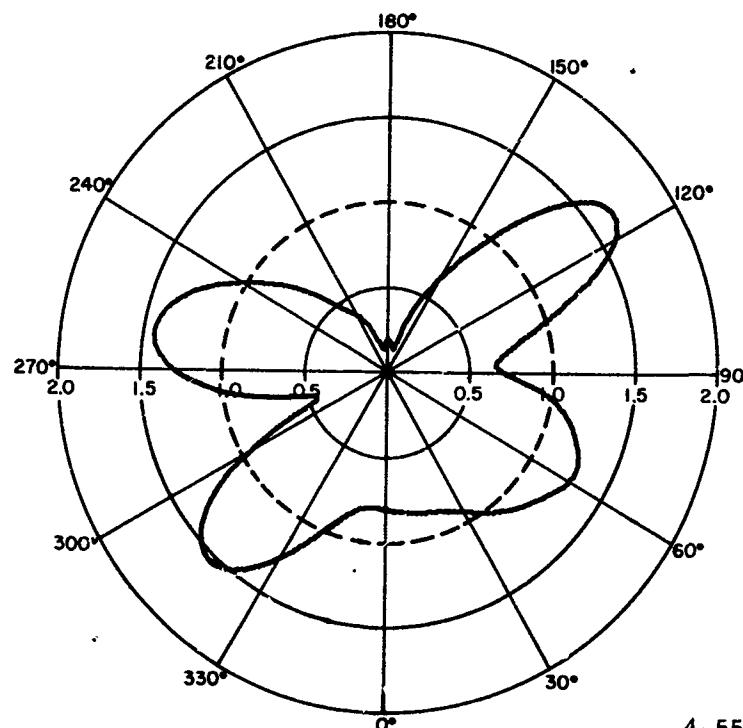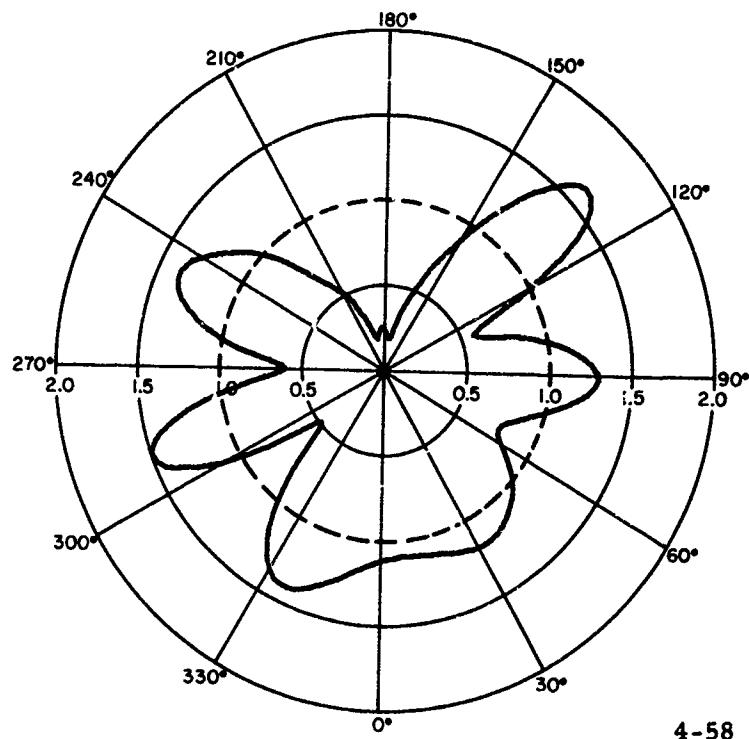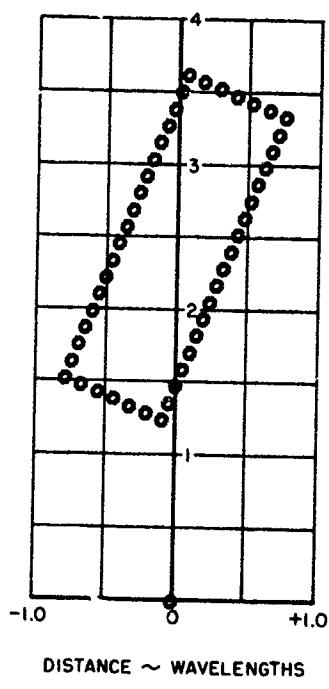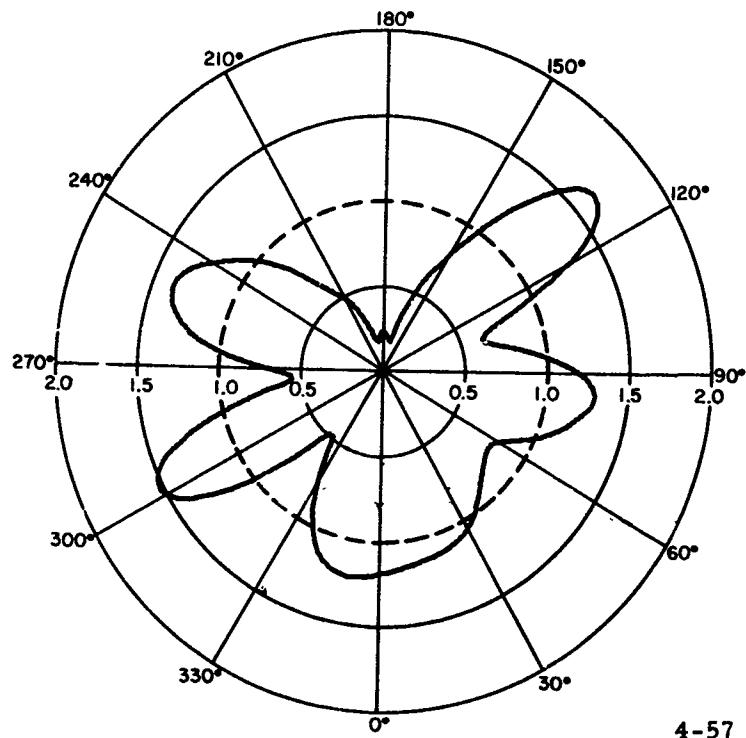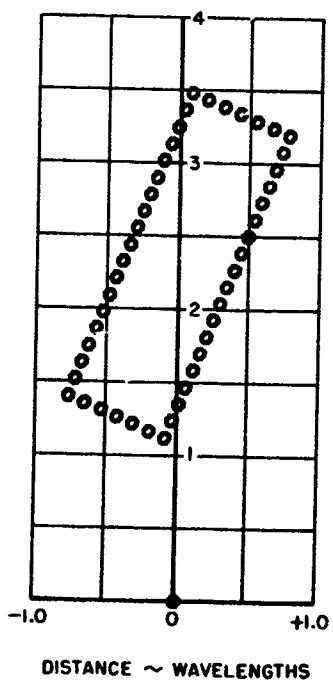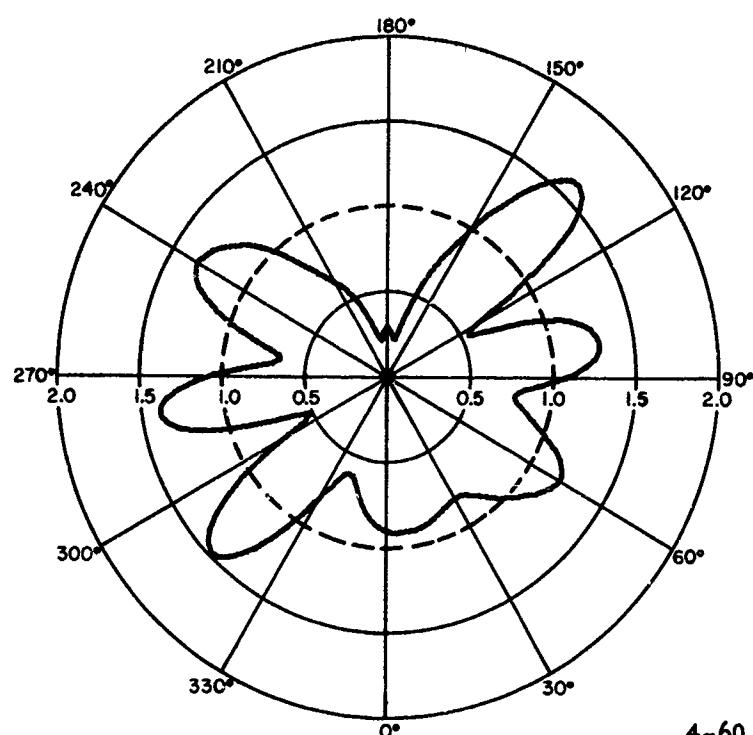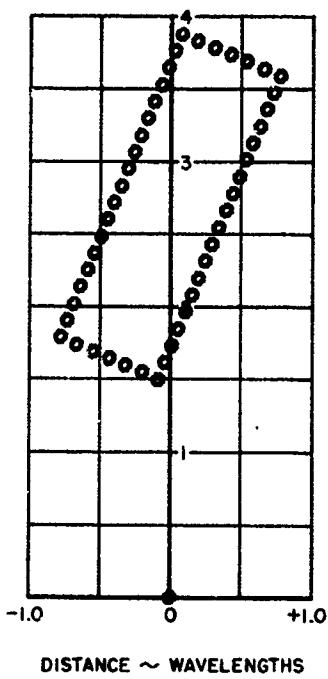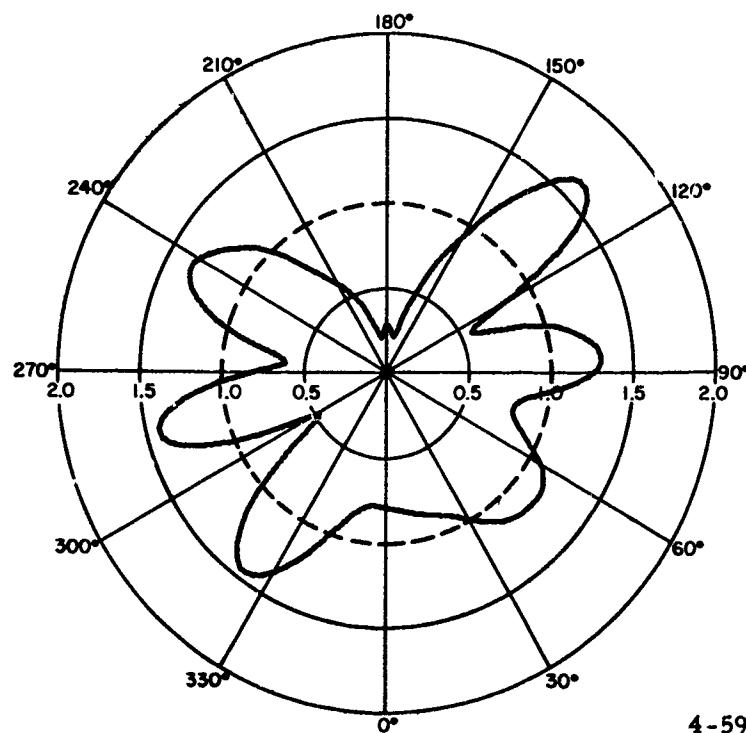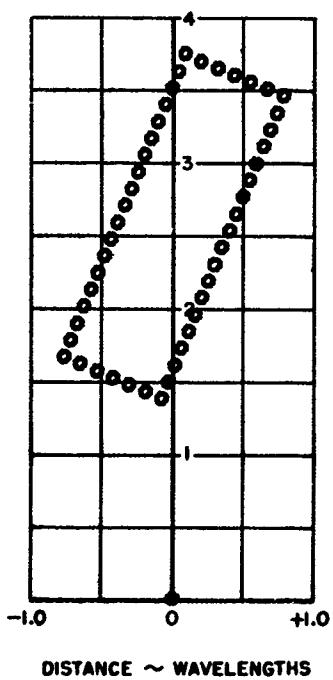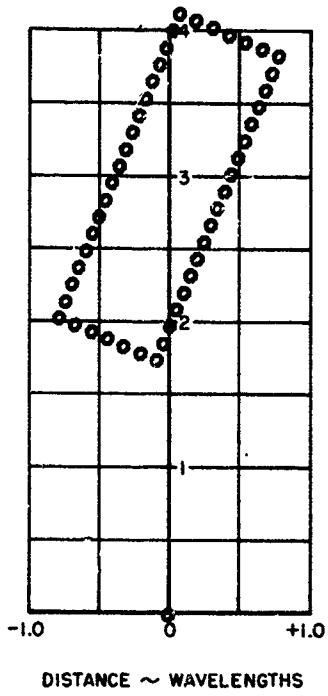
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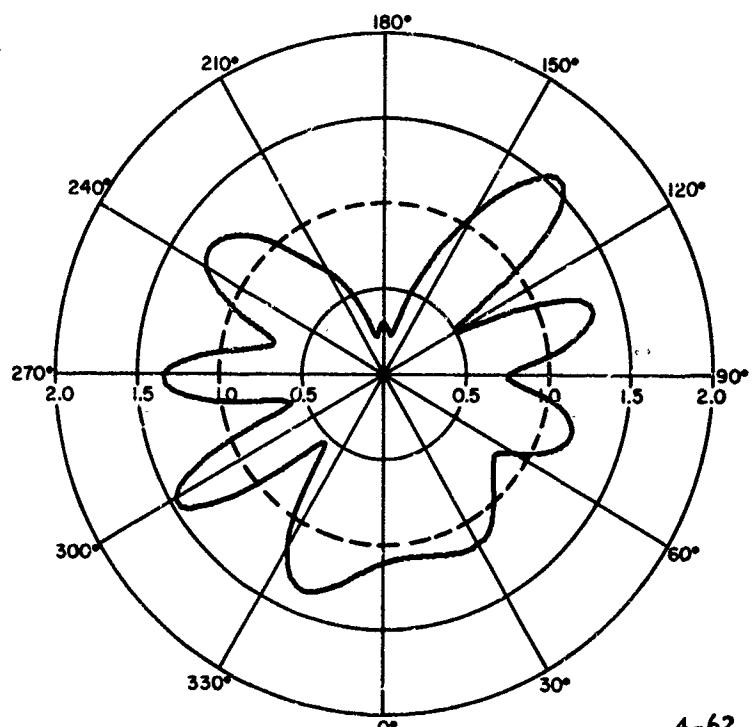
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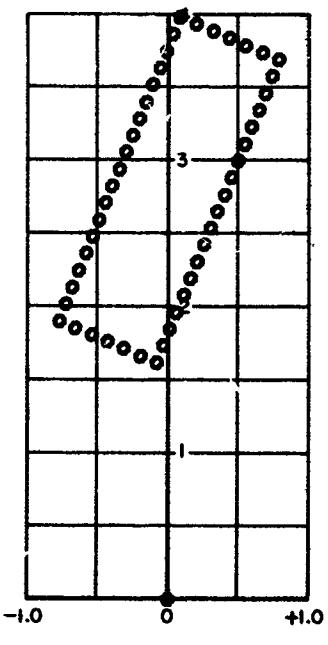
DISTANCE ~ WAVELENGTHS

4-61

151
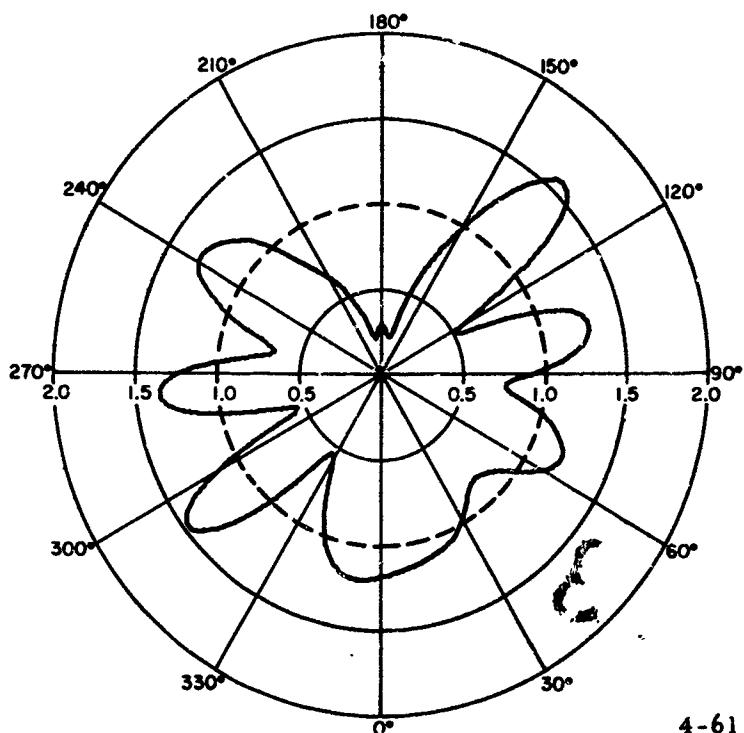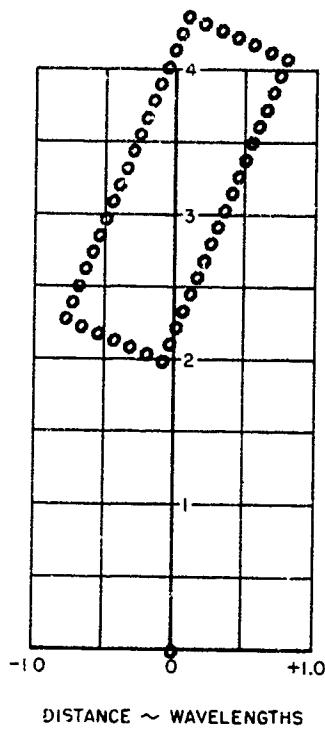
DISTANCE ~ WAVELENGTHS

4-64

DISTANCE ~ WAVELENGTHS

4-63

152

DISTANCE ~ WAVELENGTHS

4-66

DISTANCE ~ WAVELENGTHS

4-65

153

DISTANCE ~ WAVELENGTHS

4-68

DISTANCE ~ WAVELENGTHS

4-67

154
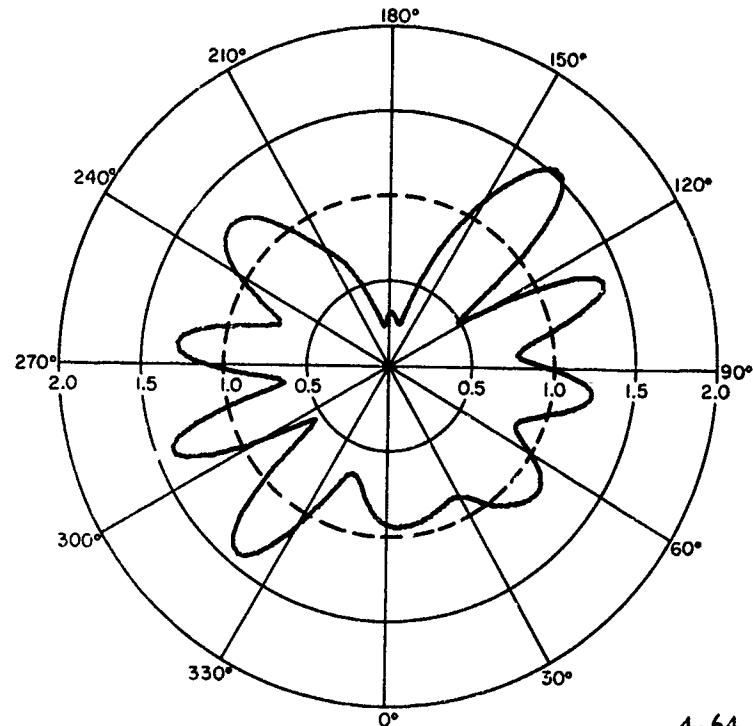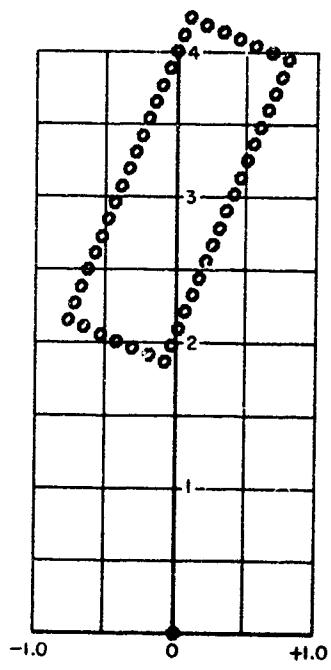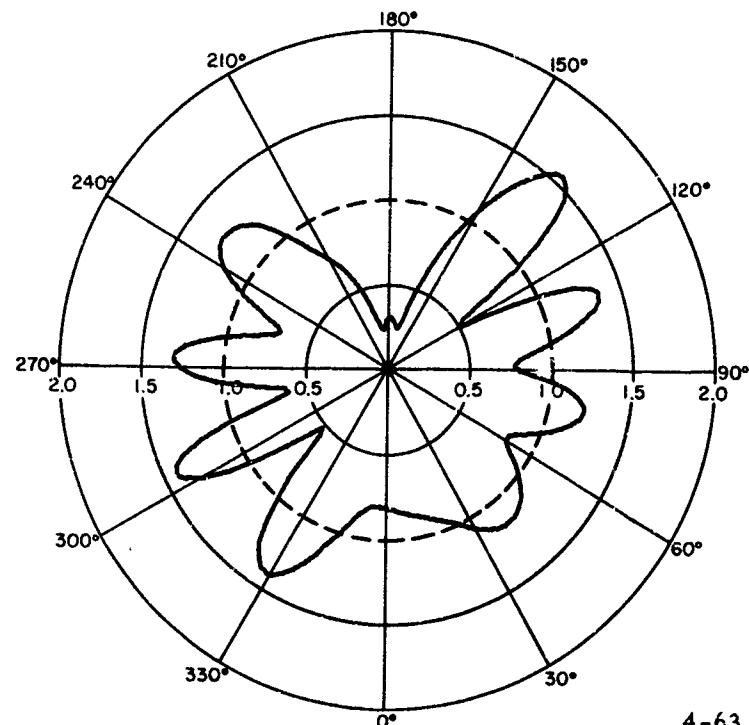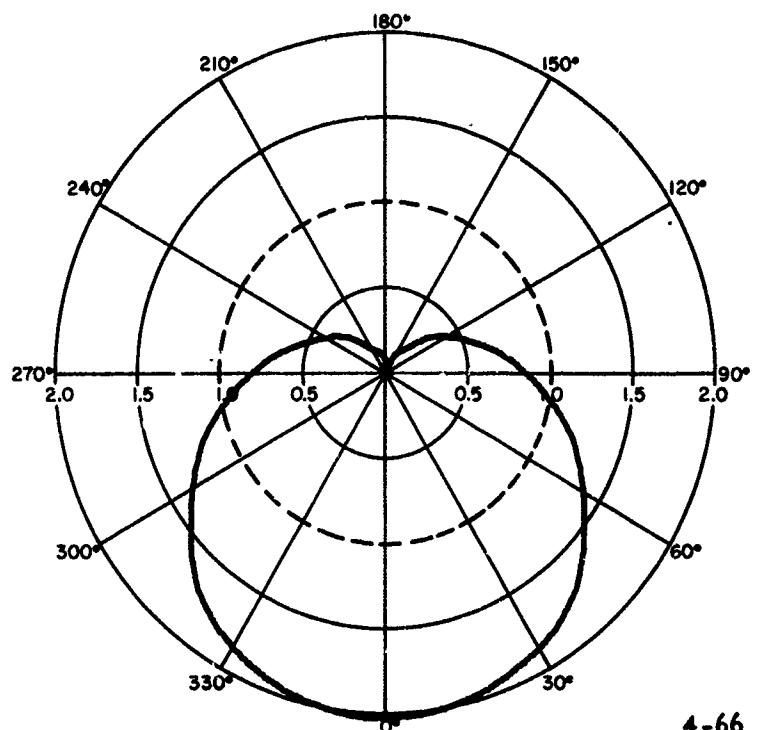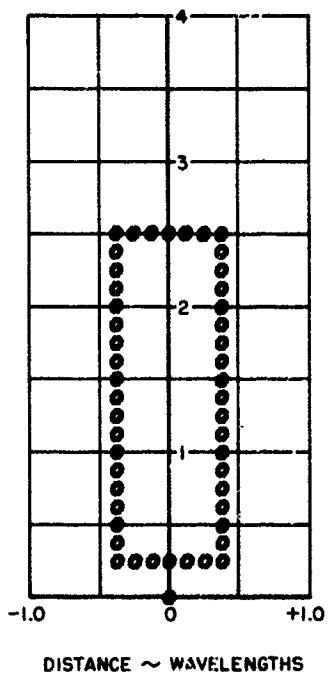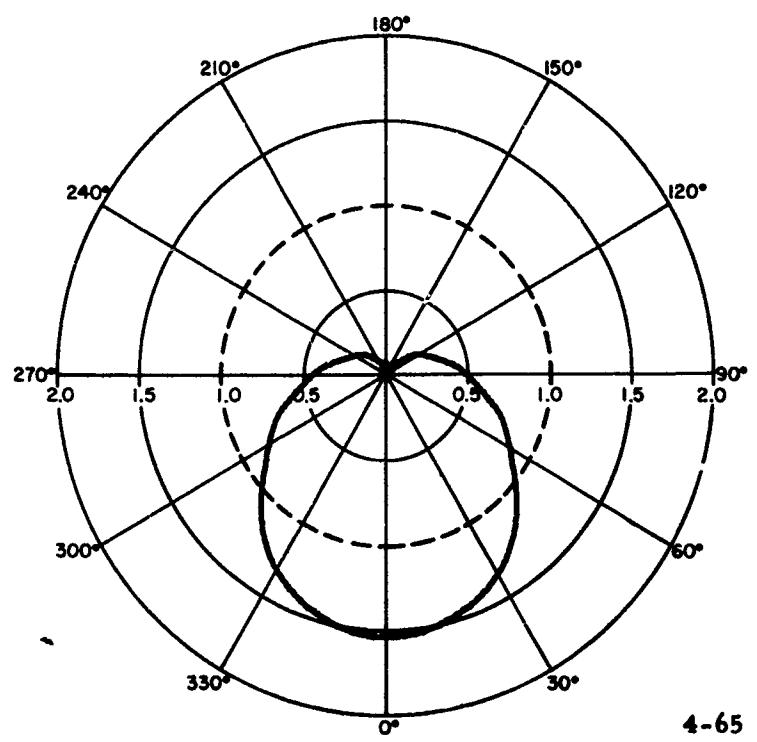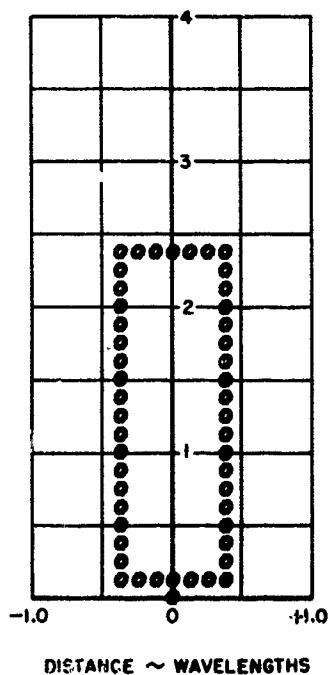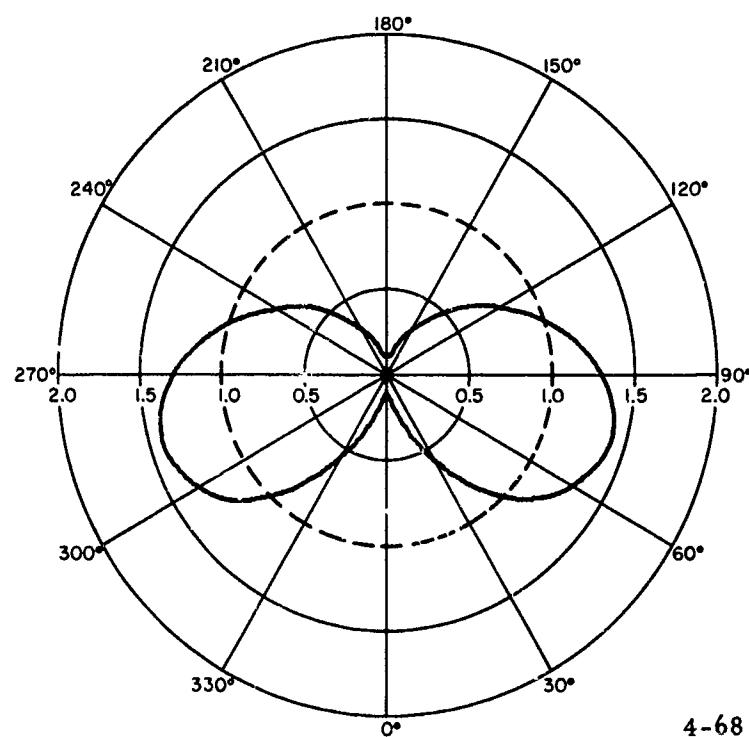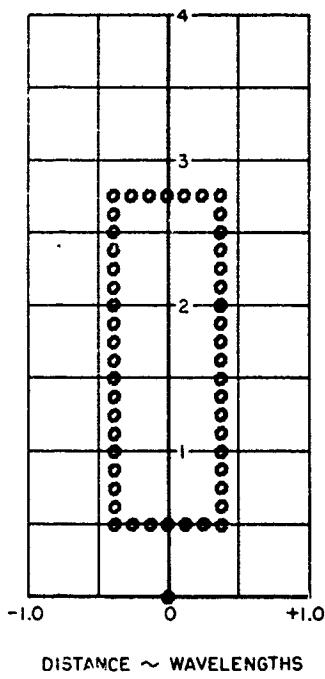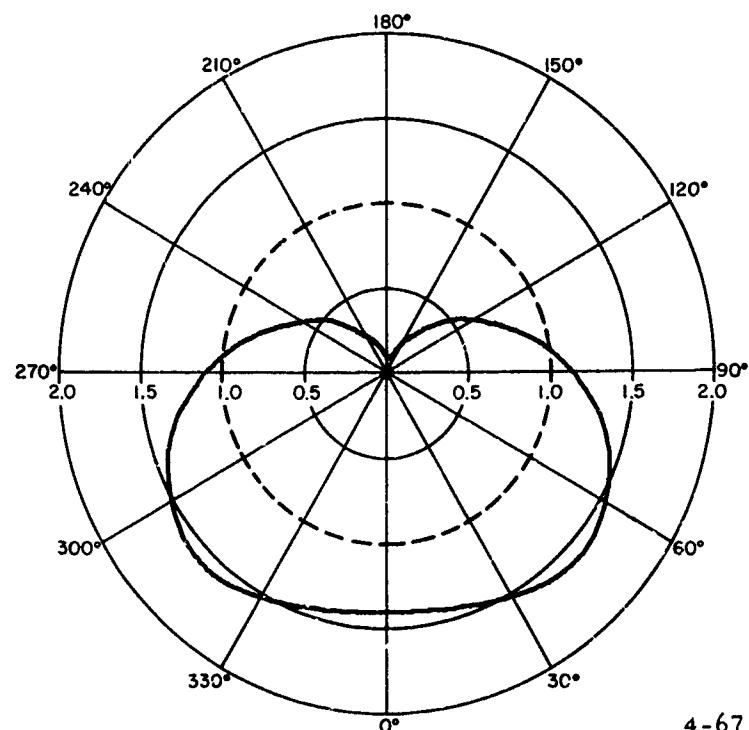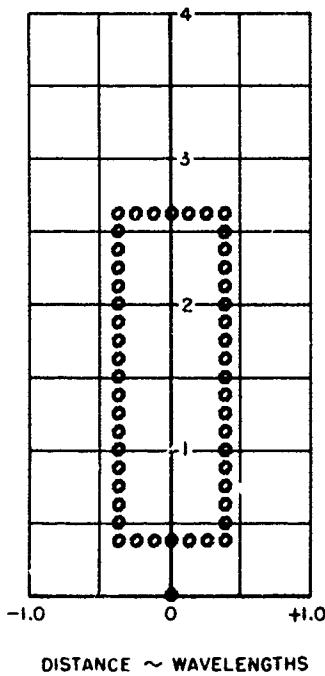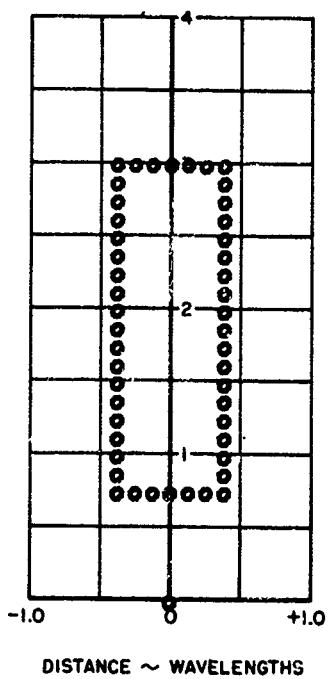
DISTANCE ~ WAVELENGTHS

4-70

DISTANCE ~ WAVELENGTHS

4-69

155

DISTANCE ~ WAVELENGTHS

4-72

DISTANCE ~ WAVELENGTHS

4-71

156
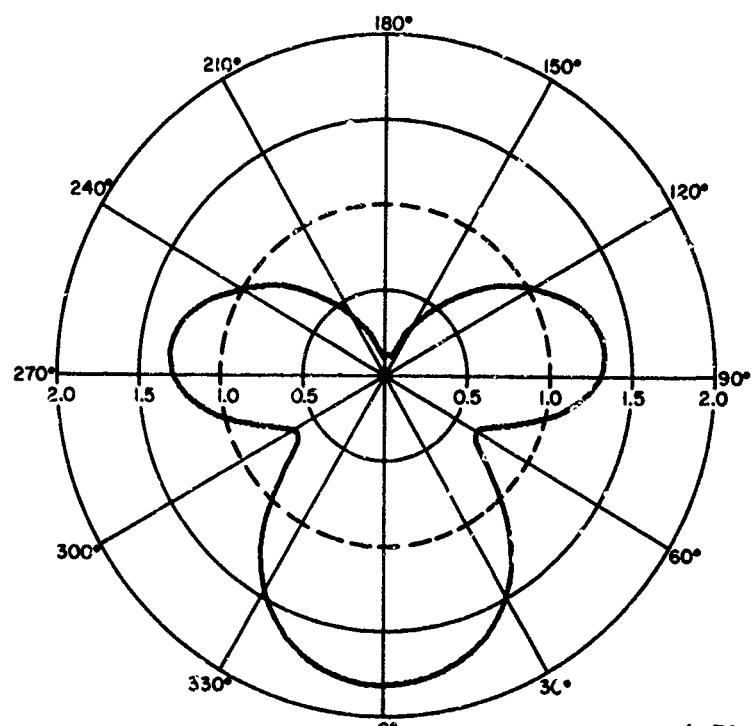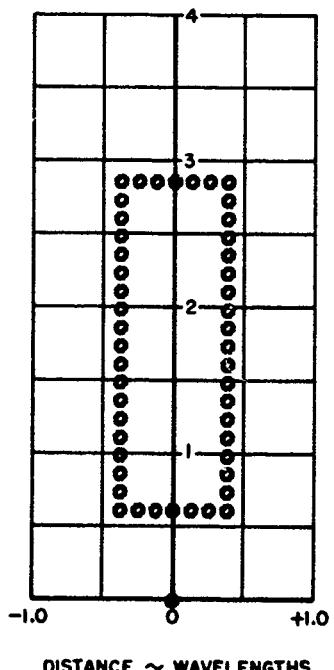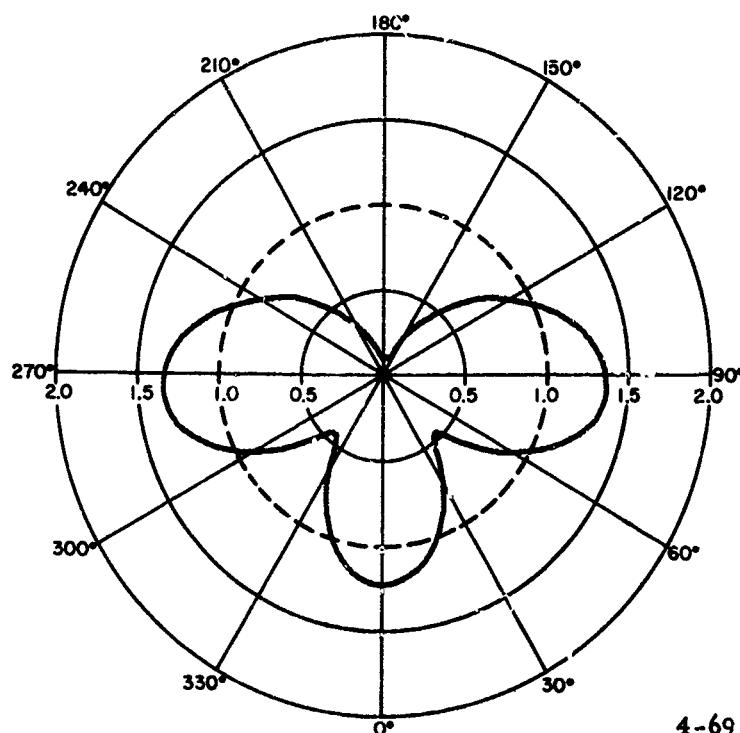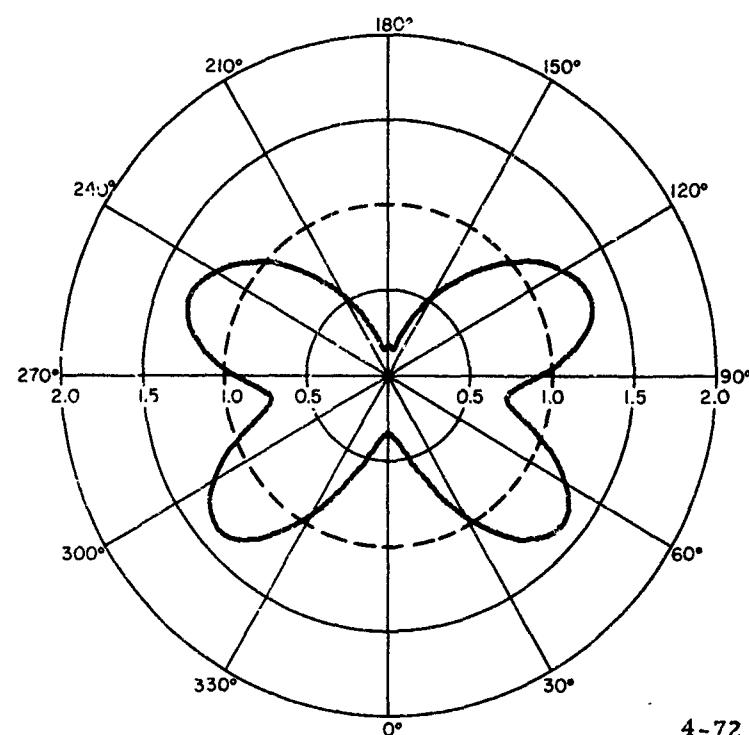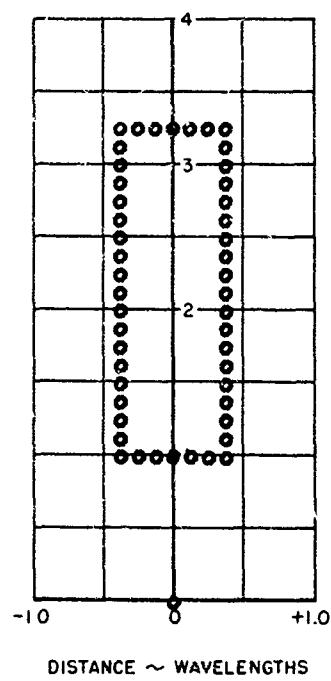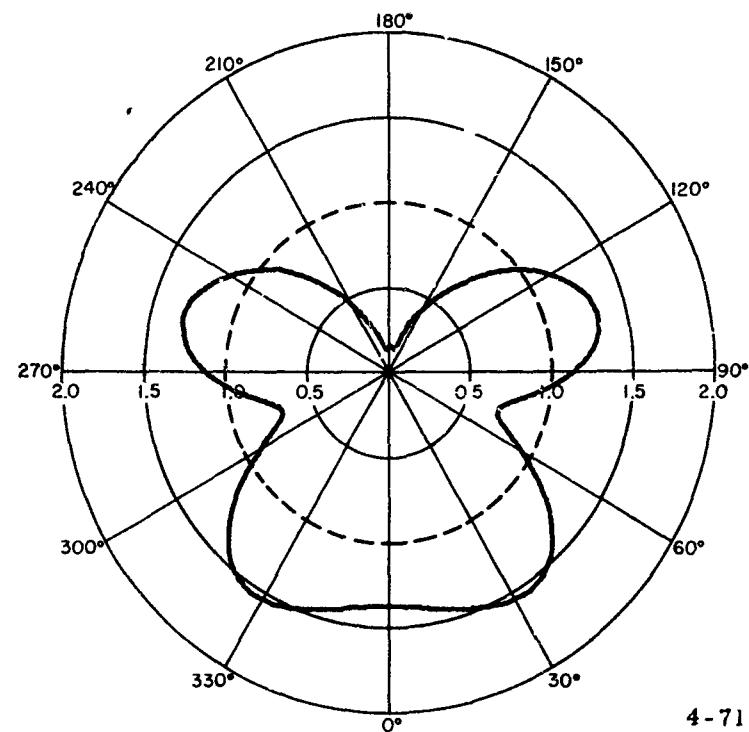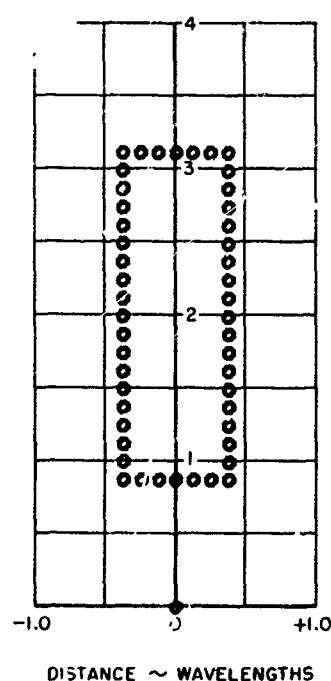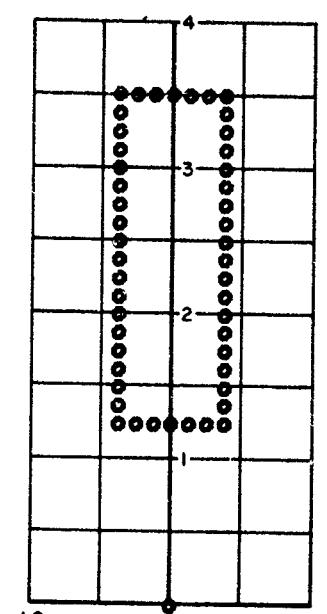
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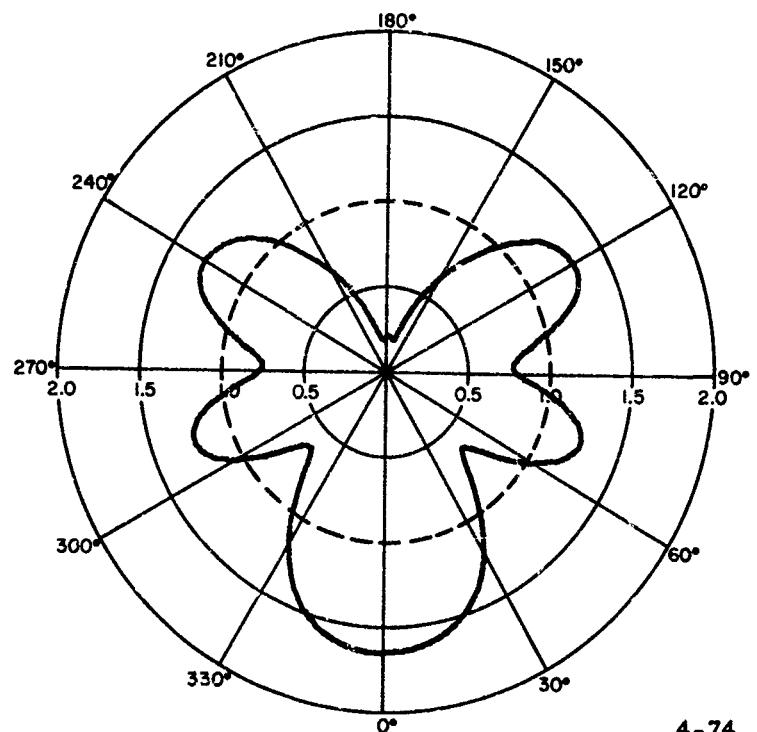
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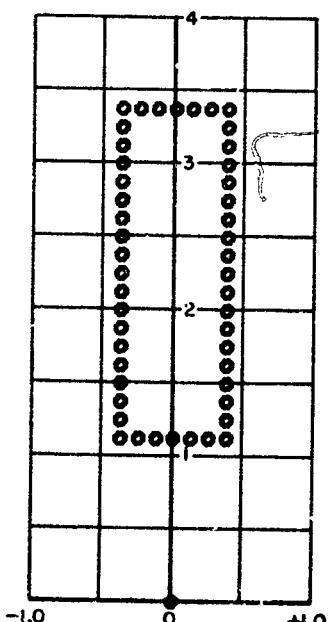
DISTANCE ~ WAVELENGTHS

4-73

157
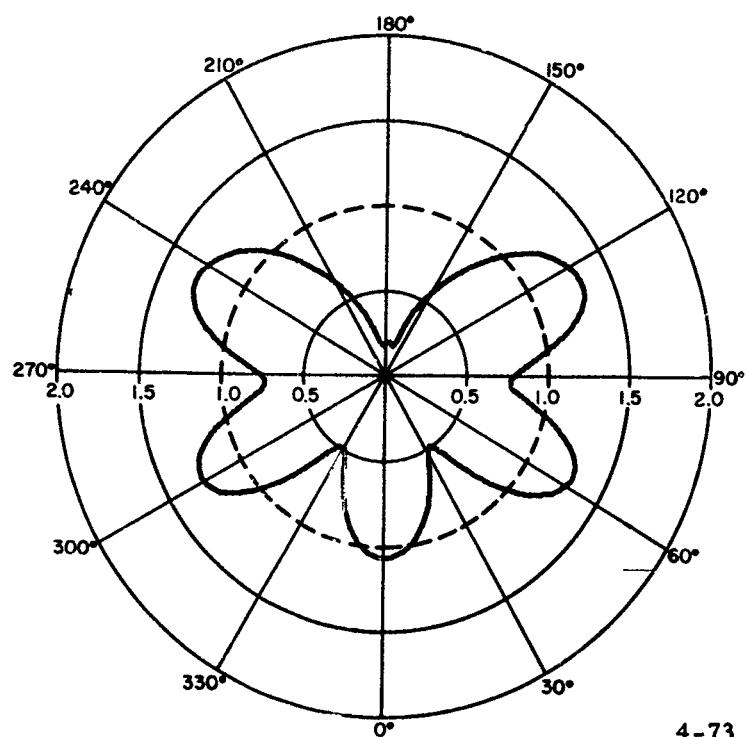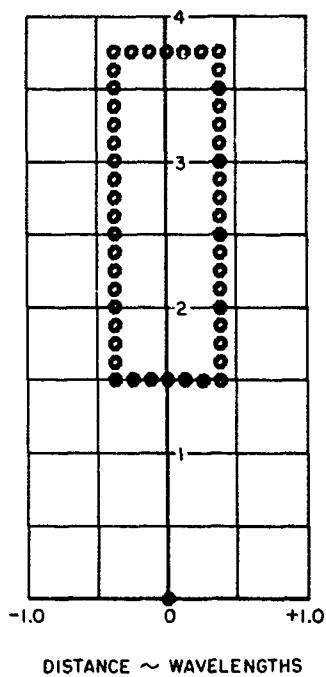
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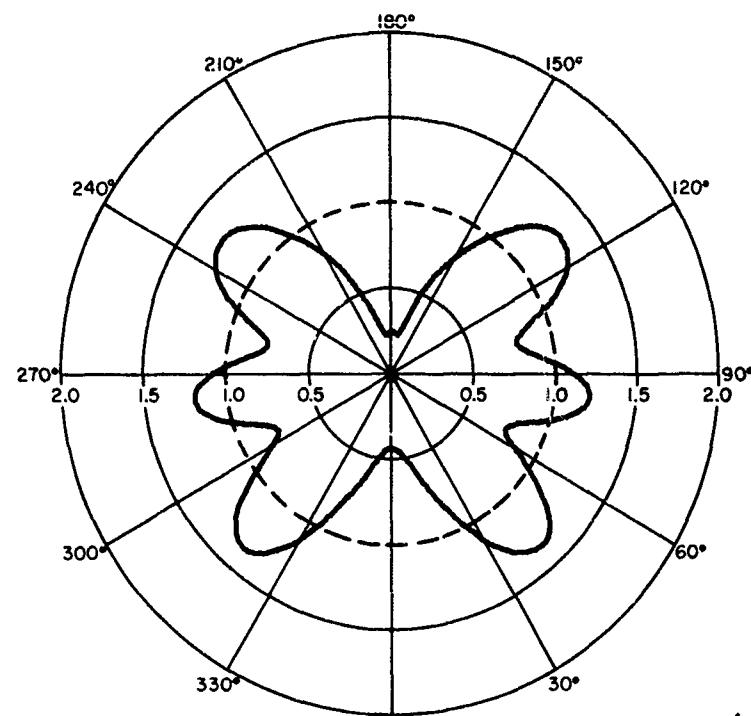
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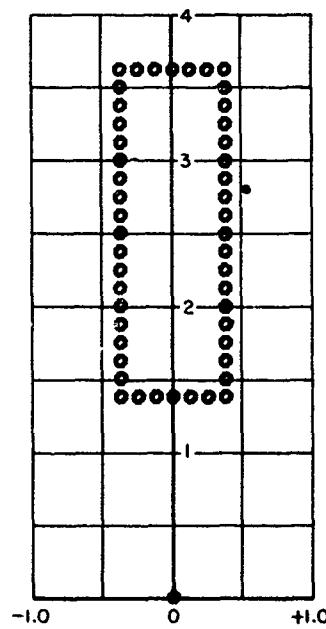
DISTANCE ~ WAVELENGTHS

4-75

158
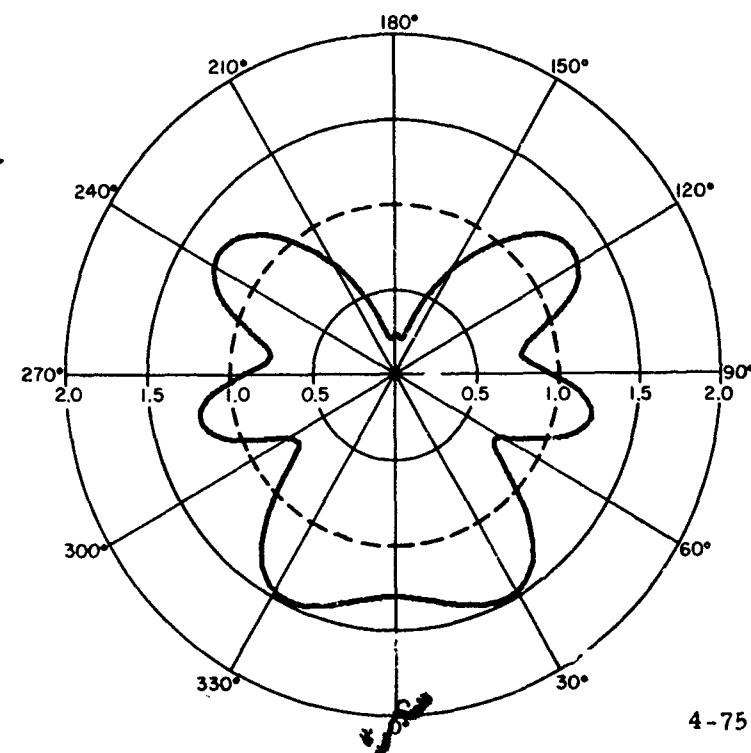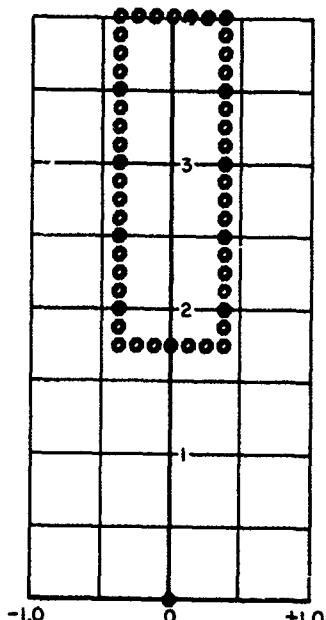
DISTANCE ~ WAVELENGTHS

4-78

DISTANCE ~ WAVELENGTHS

4-77

159

DISTANCE ~ WAVELENGTHS

4-80

DISTANCE ~ WAVELENGTHS

4-79

160

DISTANCE ~ WAVELENGTHS

A-2

DISTANCE ~ WAVELENGTHS

A-1

161

DISTANCE ~ WAVELENGTHS

A-4

DISTANCE ~ WAVELENGTHS

A-3

162

DISTANCE ~ WAVELENGTHS

A-6

DISTANCE ~ WAVELENGTHS

A-5

163
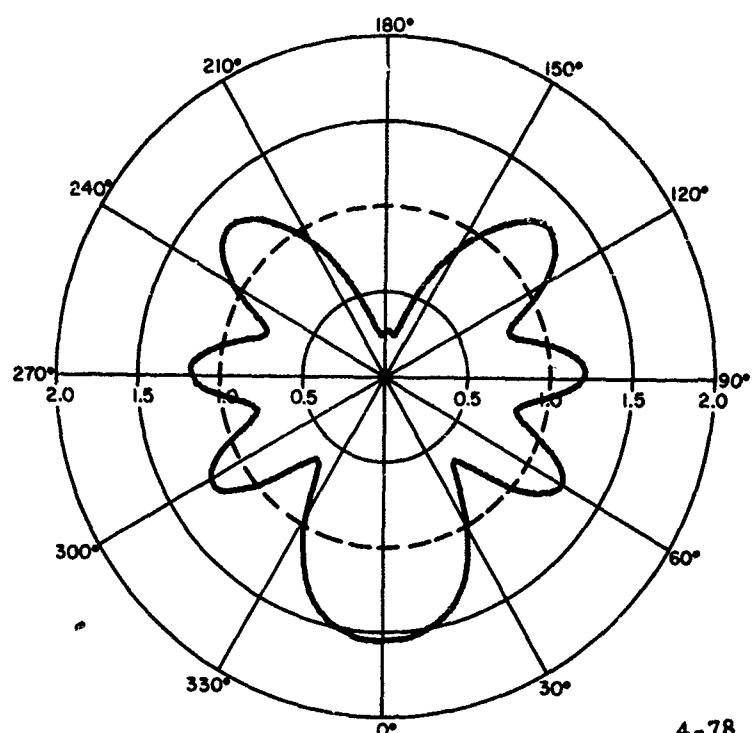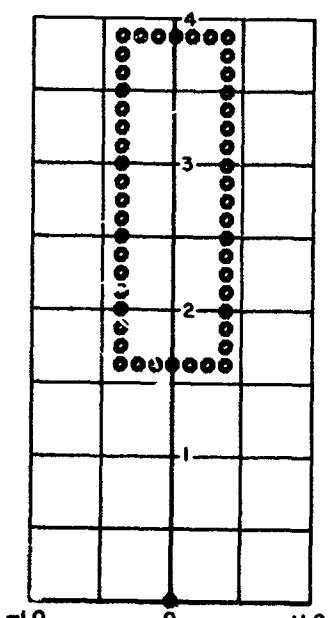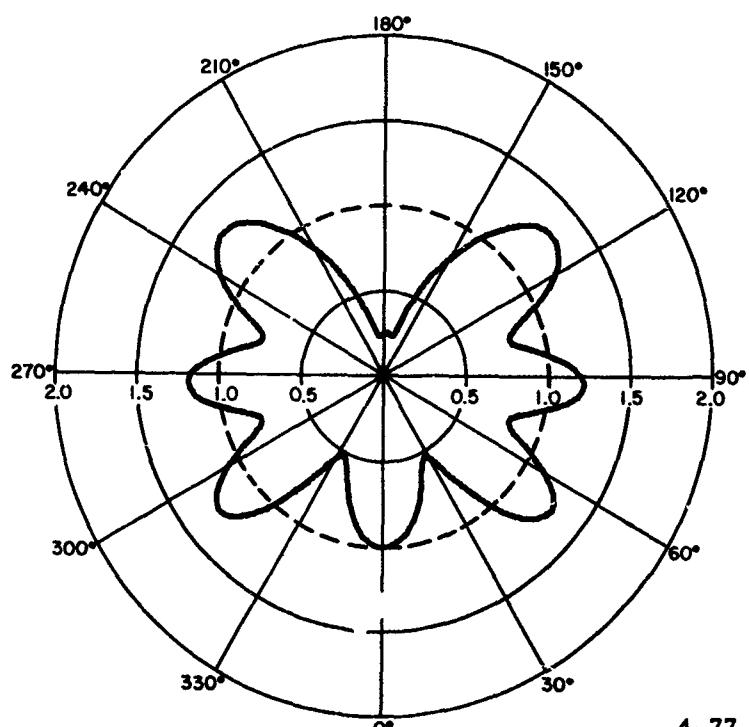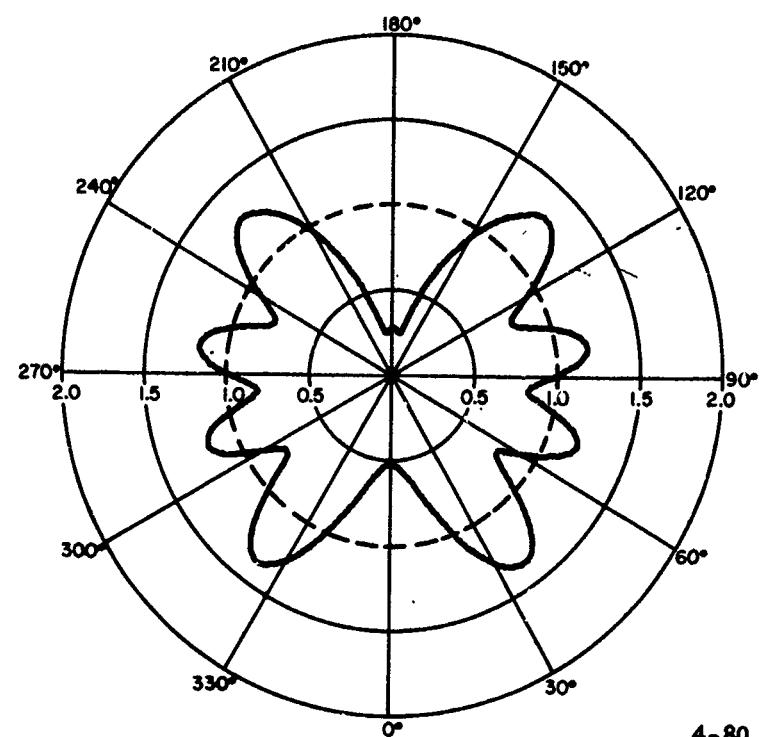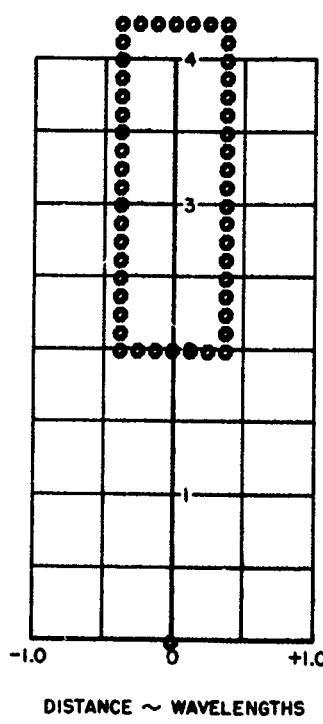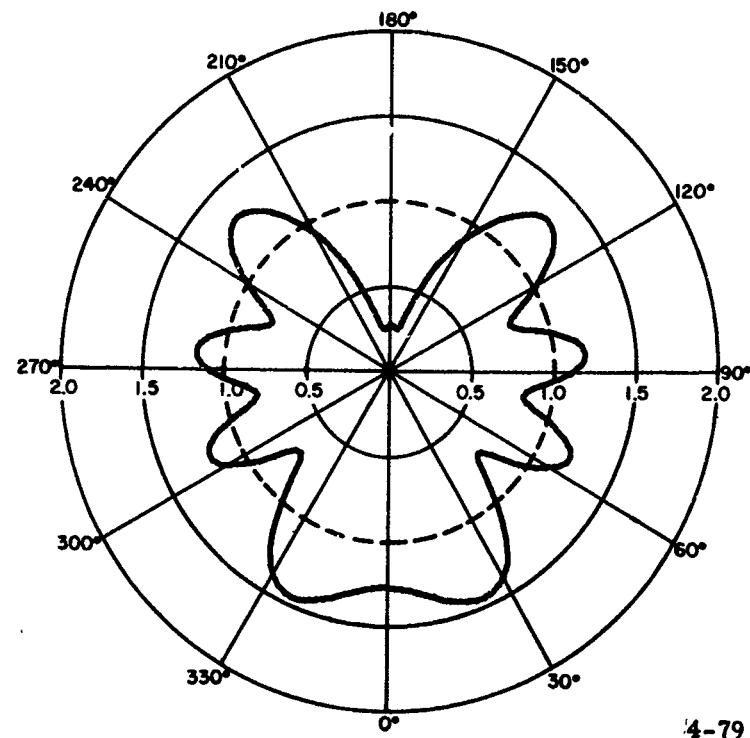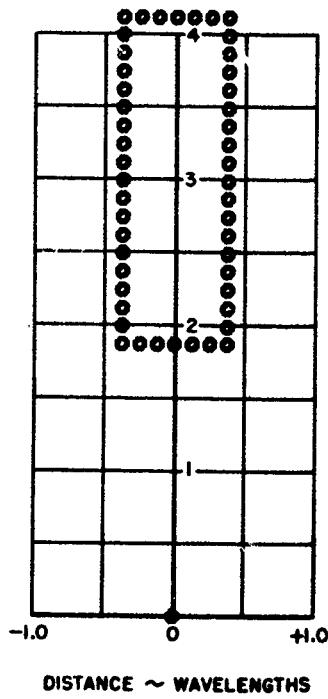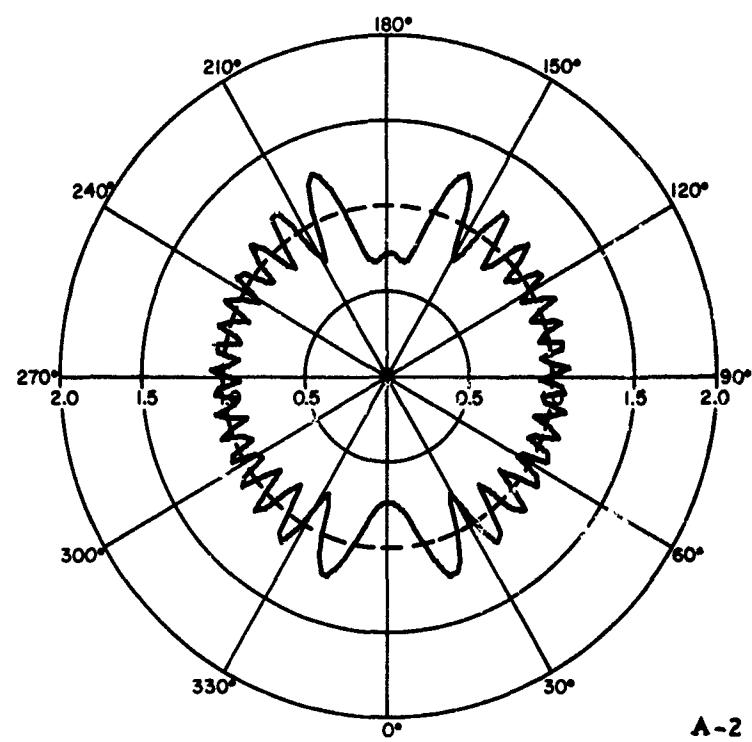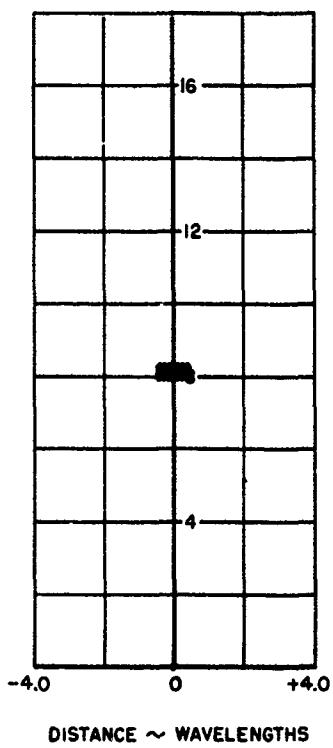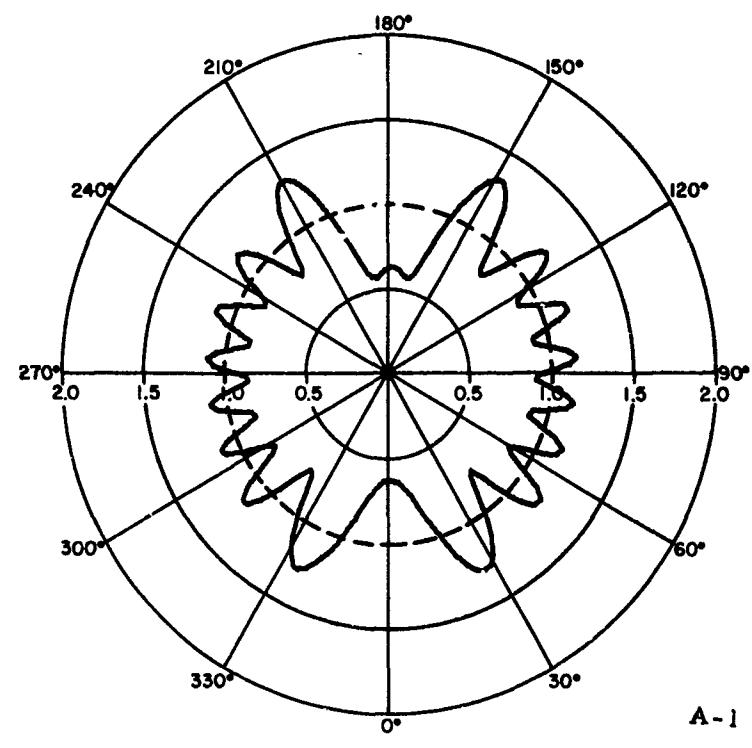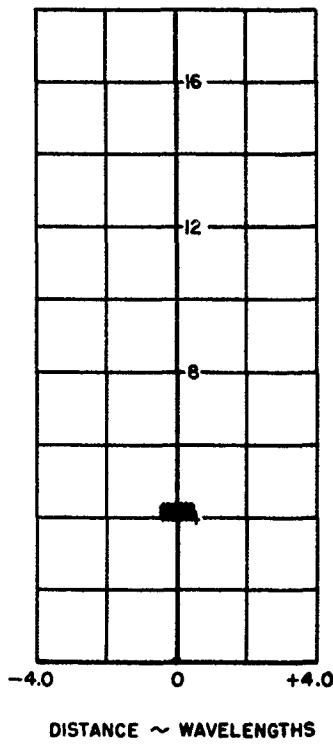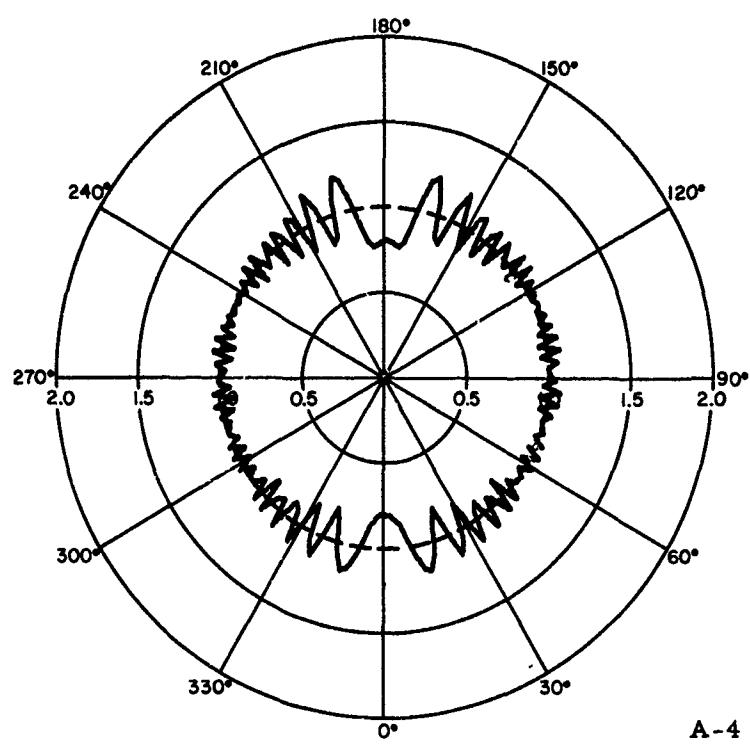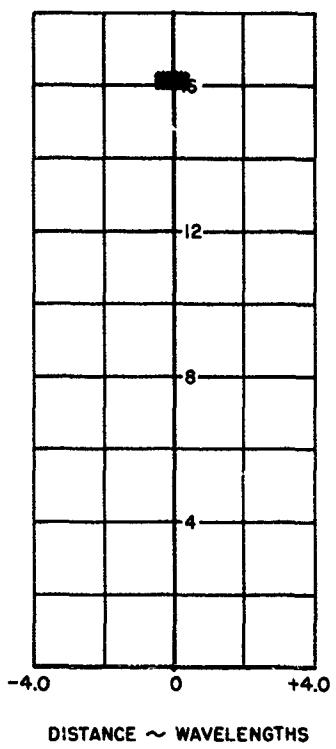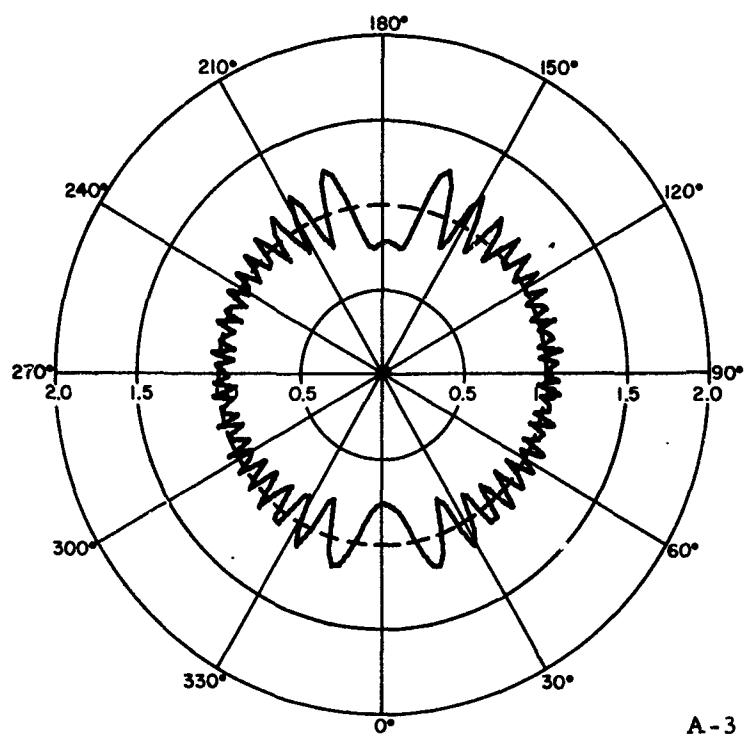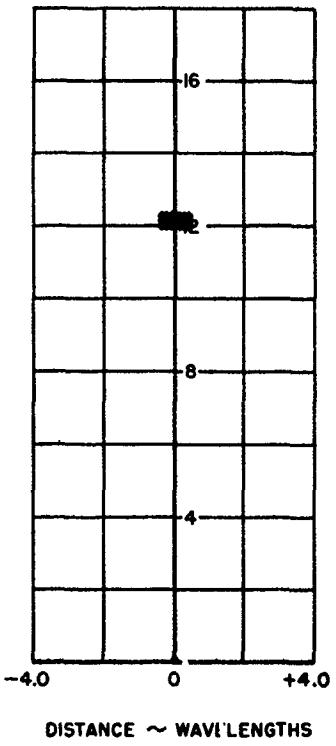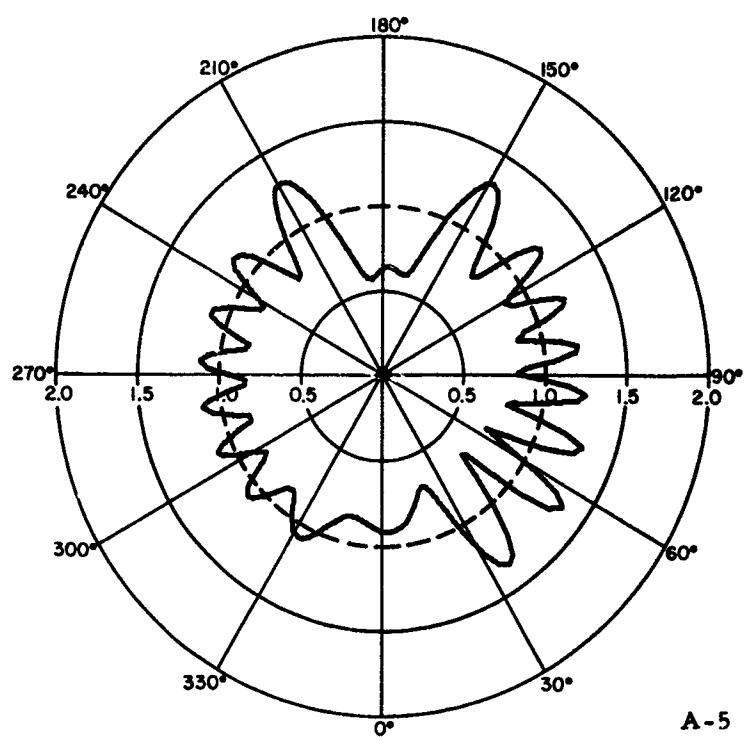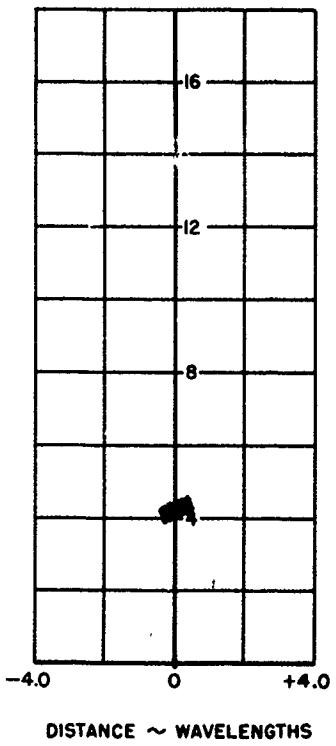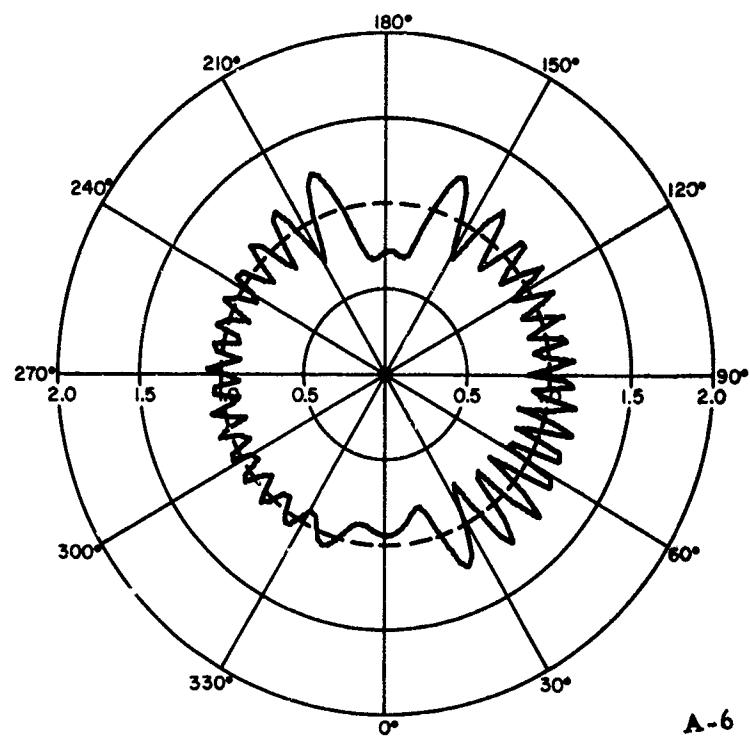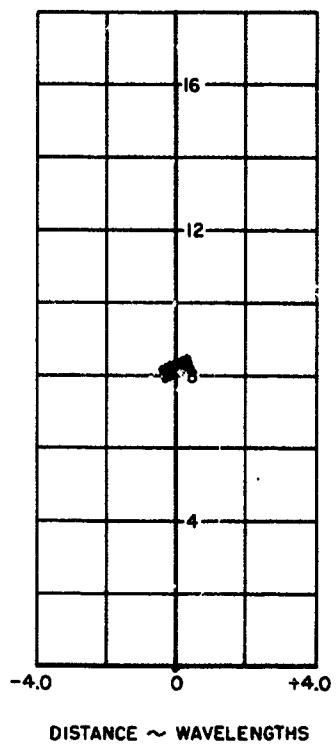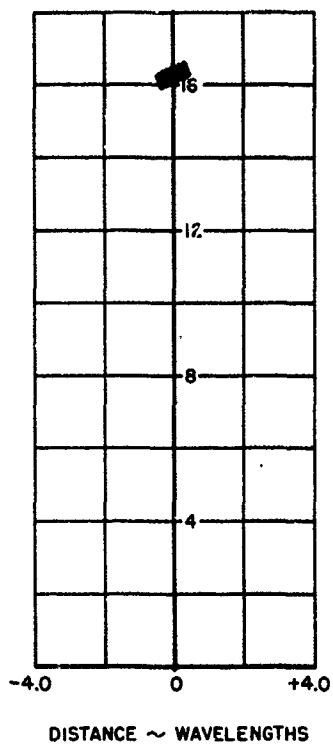
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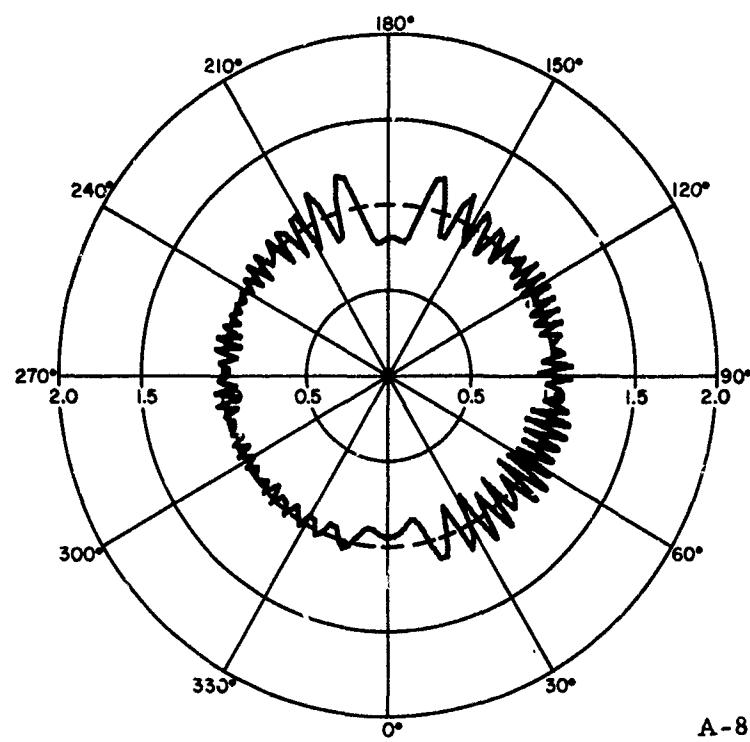
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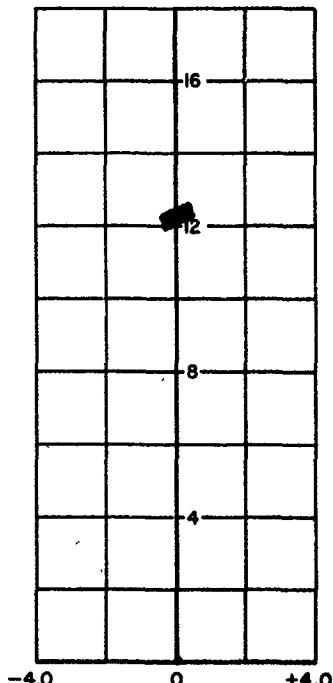
DISTANCE ~ WAVELENGTHS

A-7

164
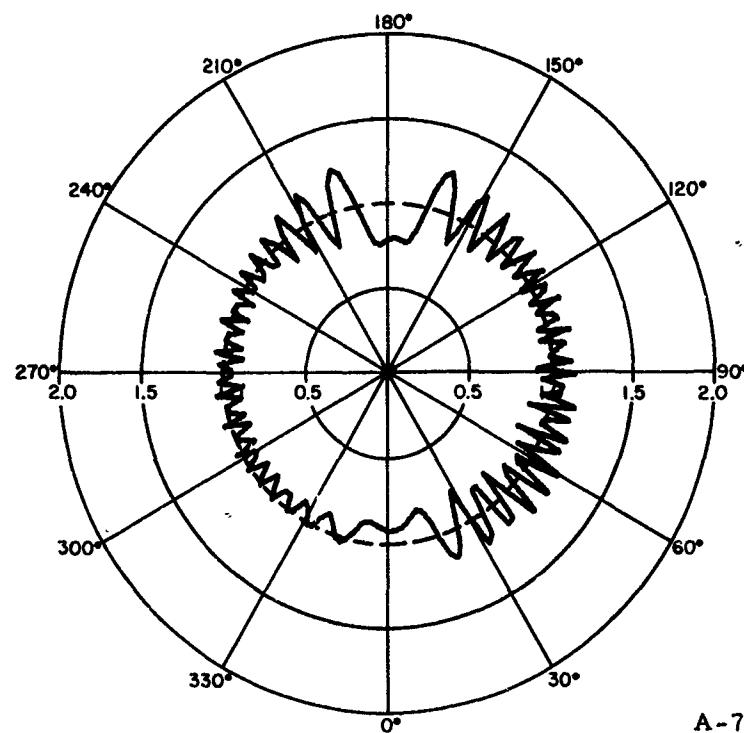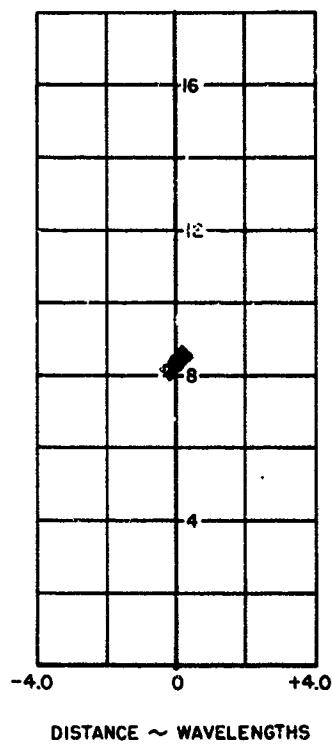
DISTANCE ~ WAVELENGTHS

A-10

DISTANCE ~ WAVELENGTHS

A-9

165

DISTANCE ~ WAVELENGTHS

A-12

DISTANCE ~ WAVELENGTHS

A-11

166

DISTANCE ~ WAVELENGTHS

A-14

DISTANCE ~ WAVELENGTHS

A-13

167

DISTANCE ~ WAVELENGTHS

A-16

DISTANCE ~ WAVELENGTHS

A-15

168

DISTANCE ~ WAVELENGTHS

A-18

DISTANCE ~ WAVELENGTHS

A-17

169

DISTANCE ~ WAVELENGTHS

A-20

DISTANCE ~ WAVELENGTHS

A-19

170
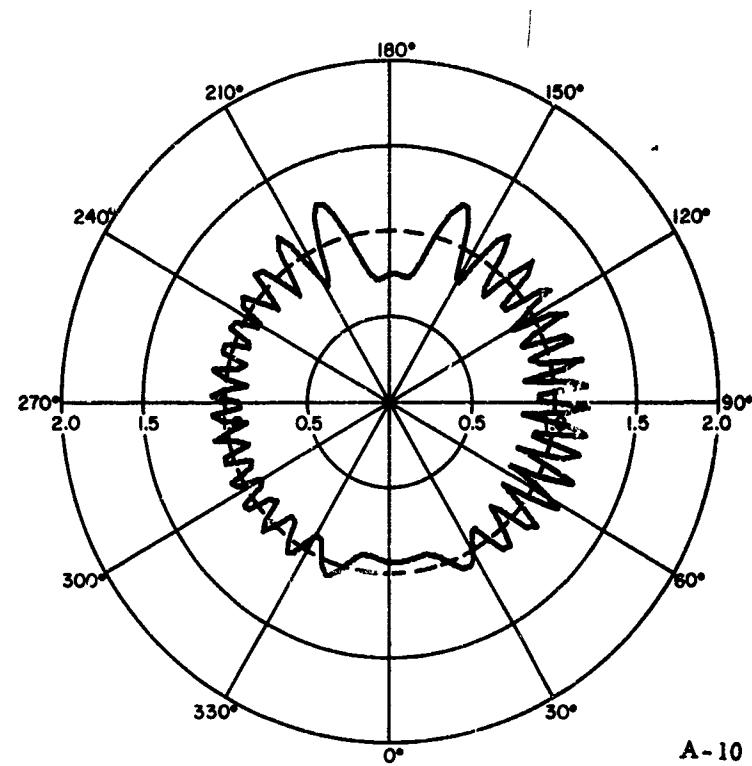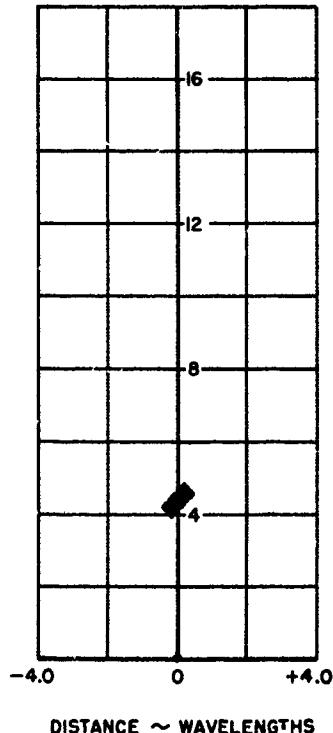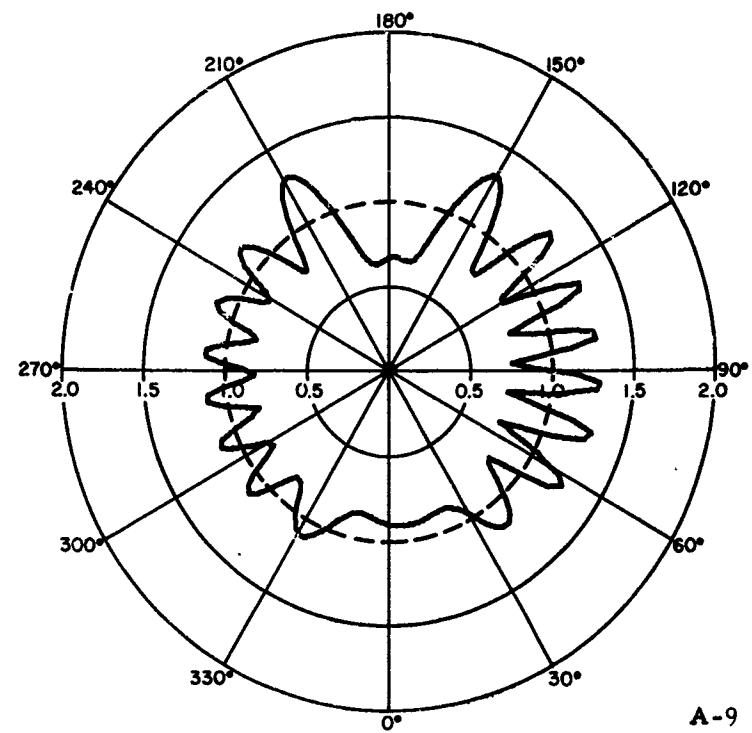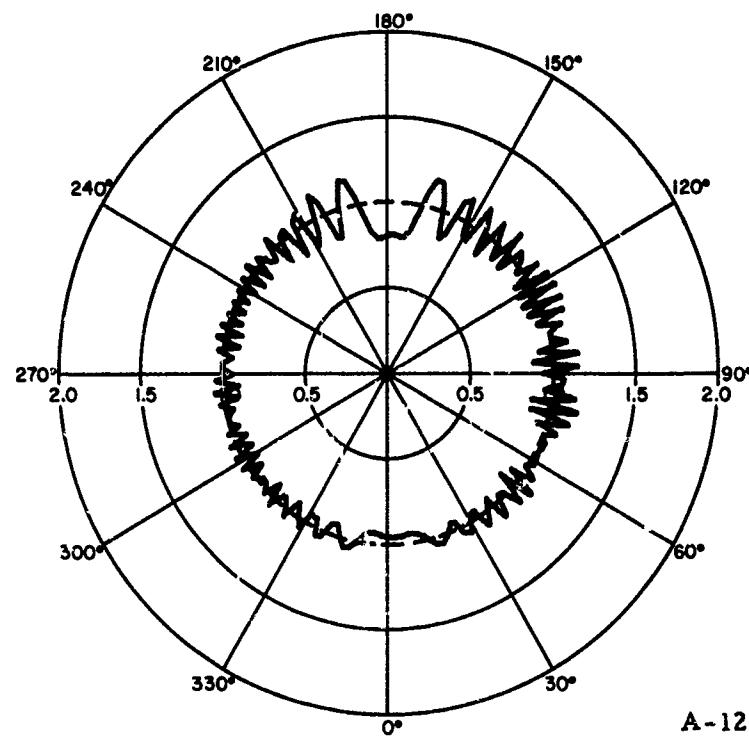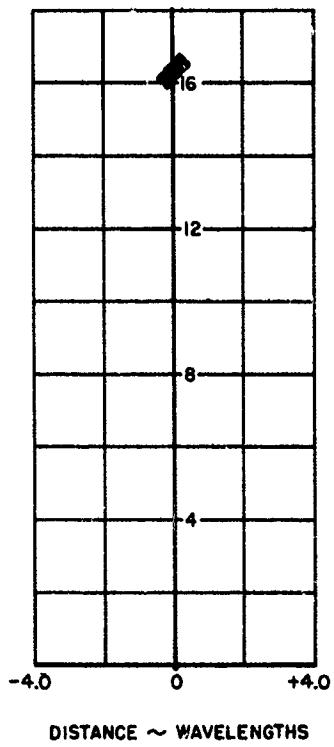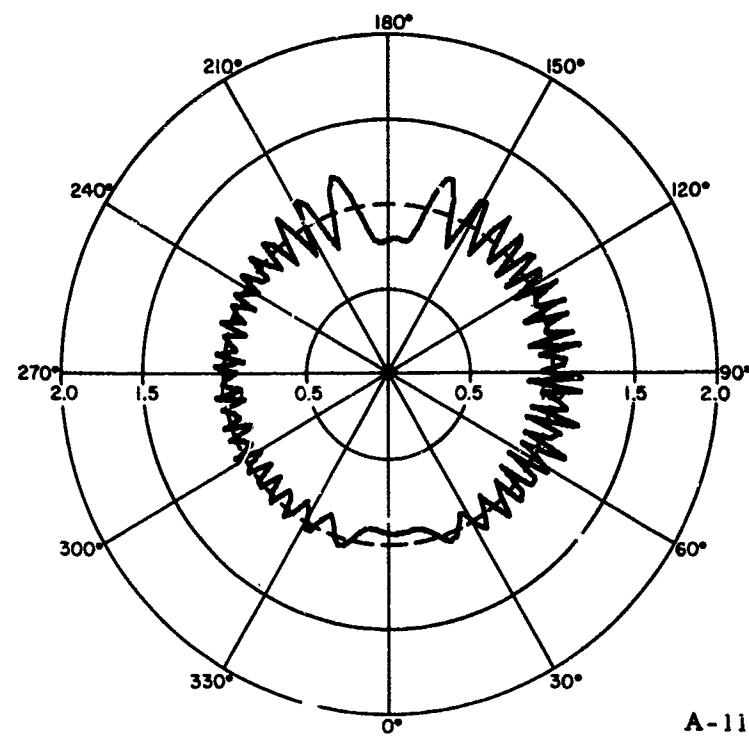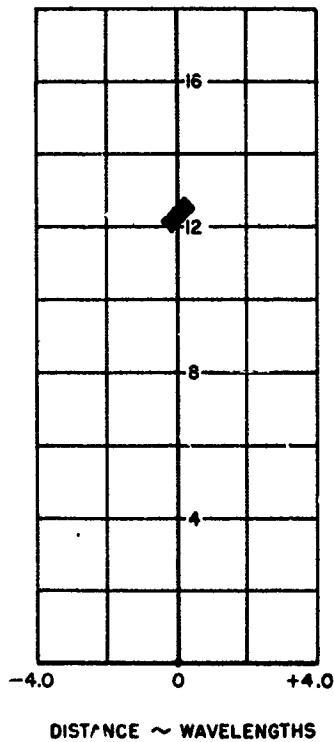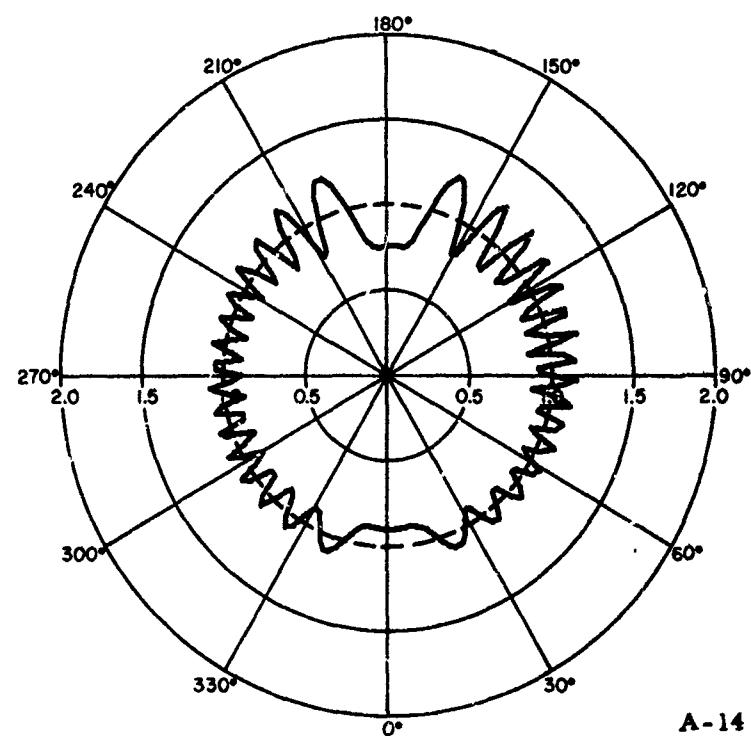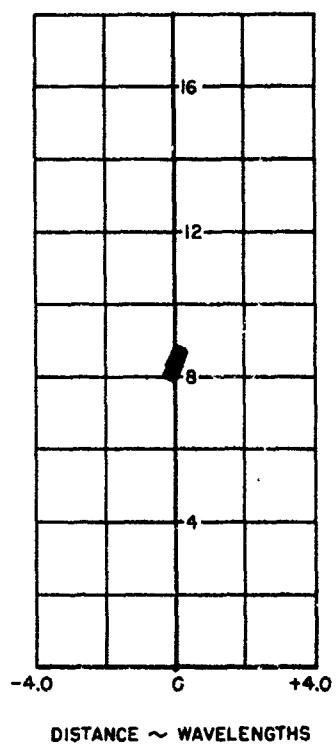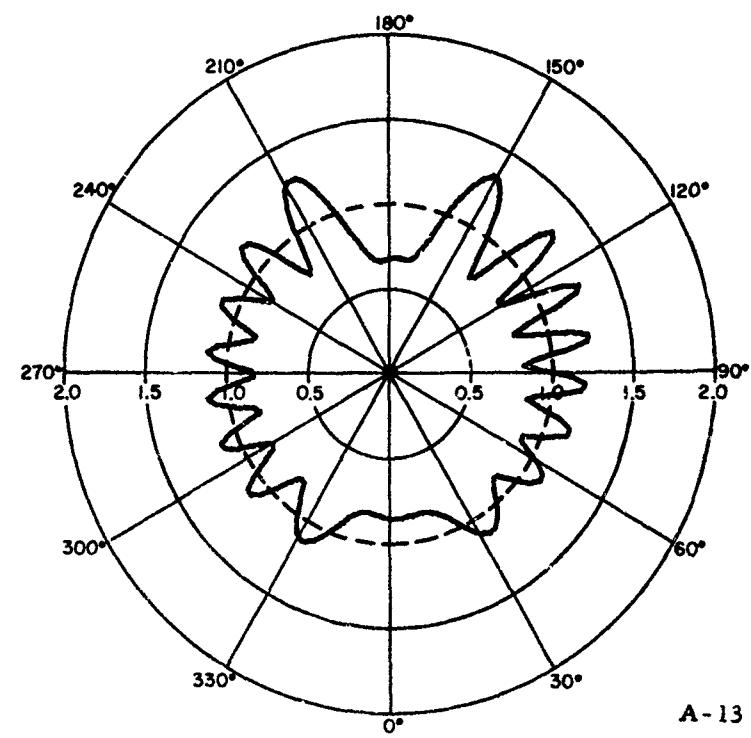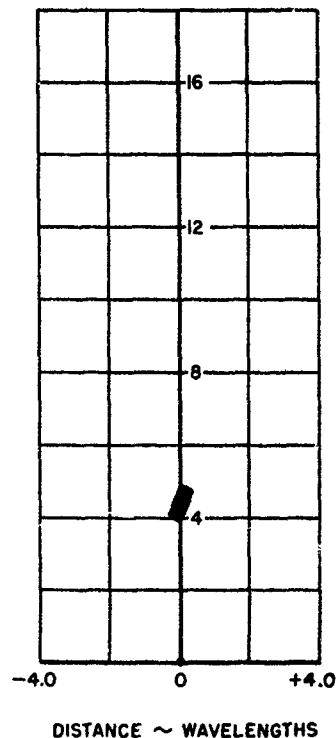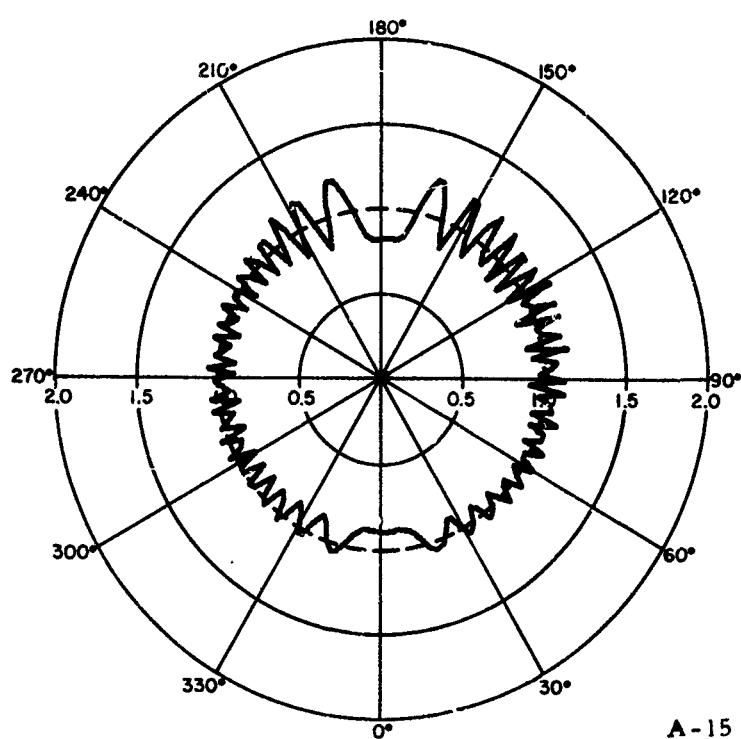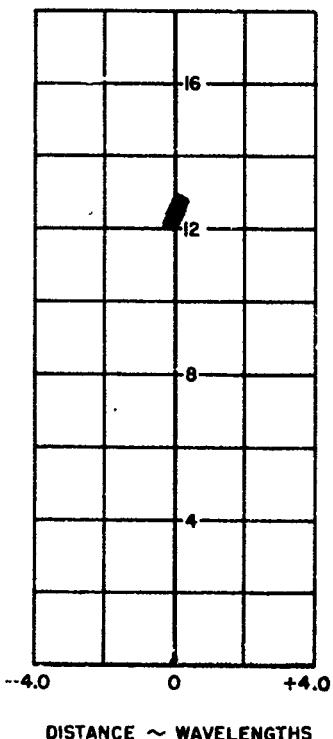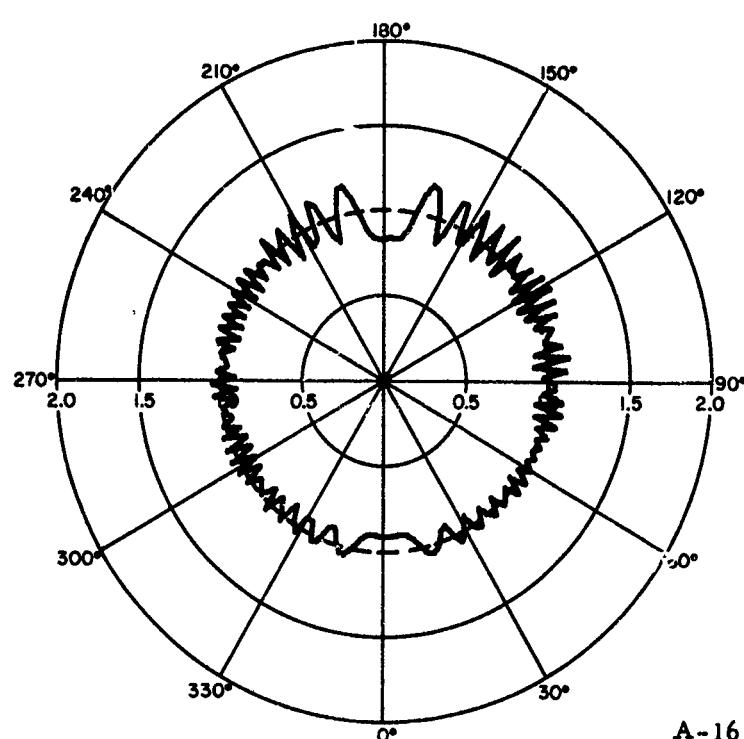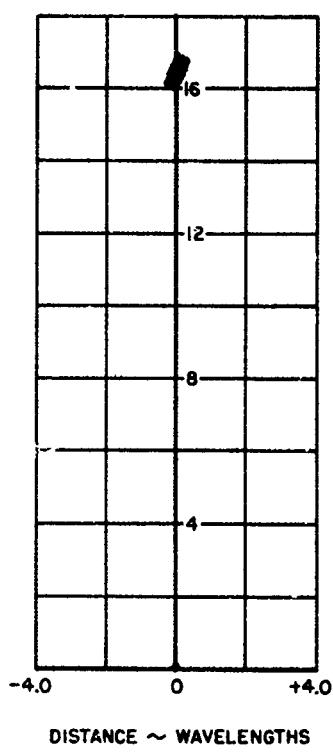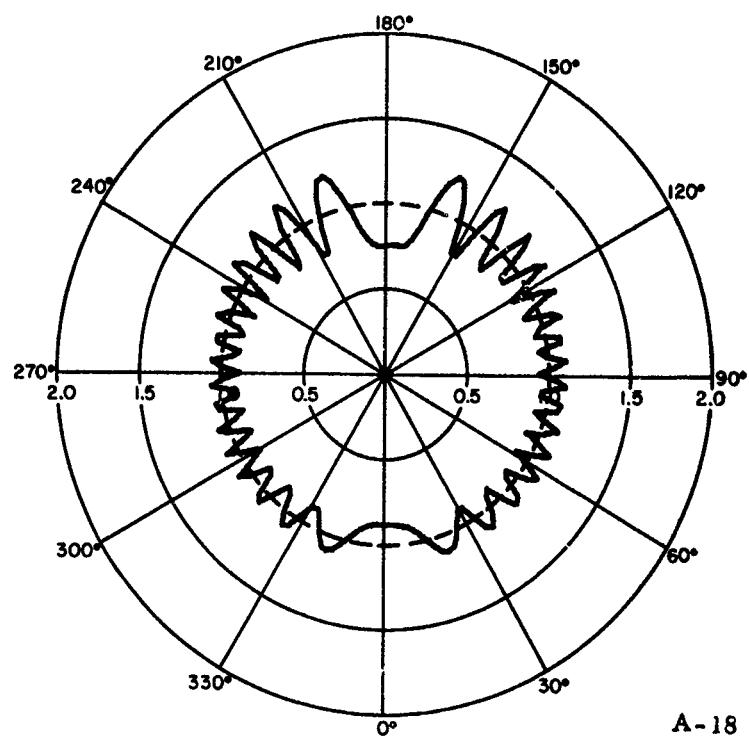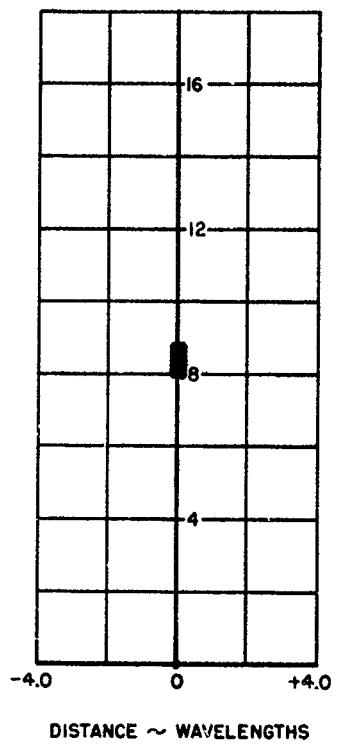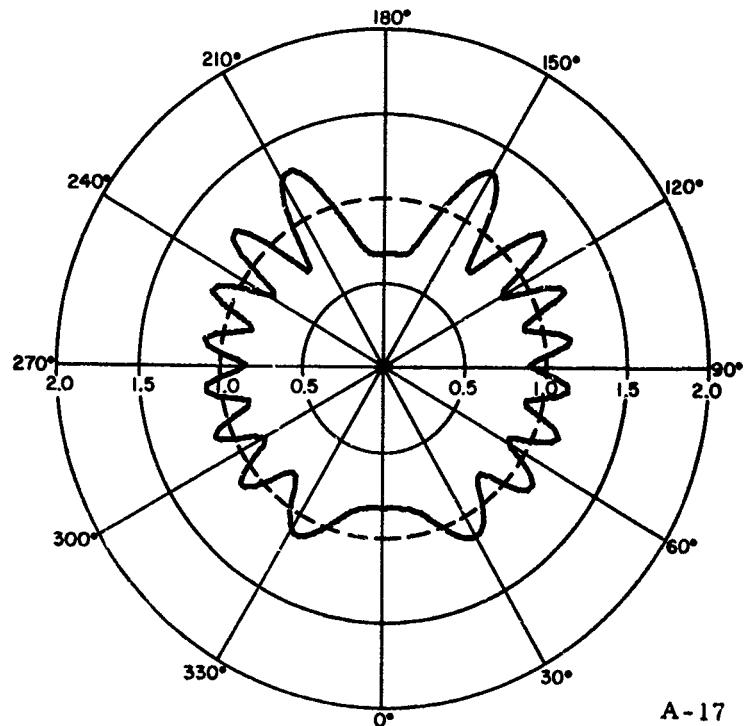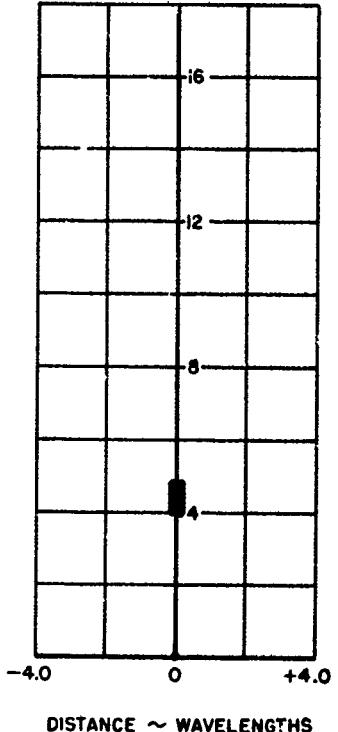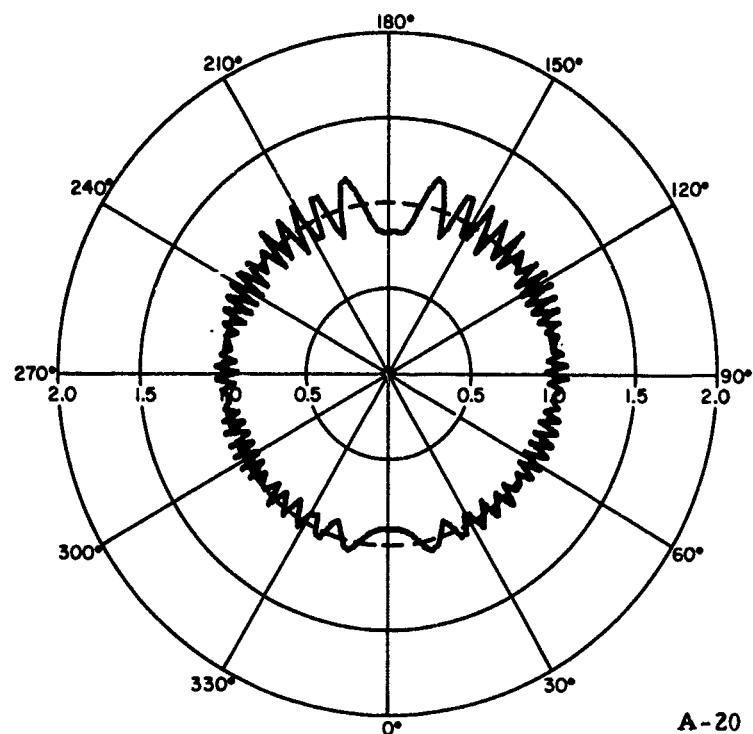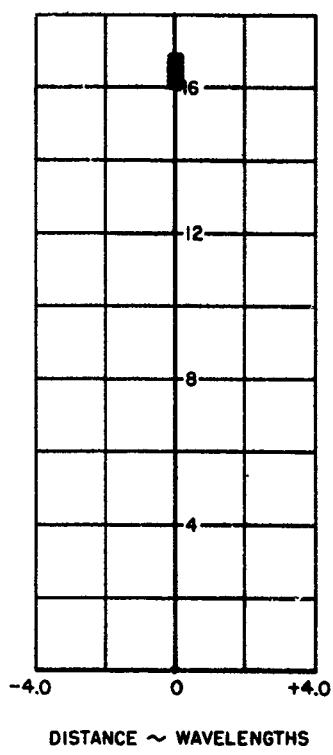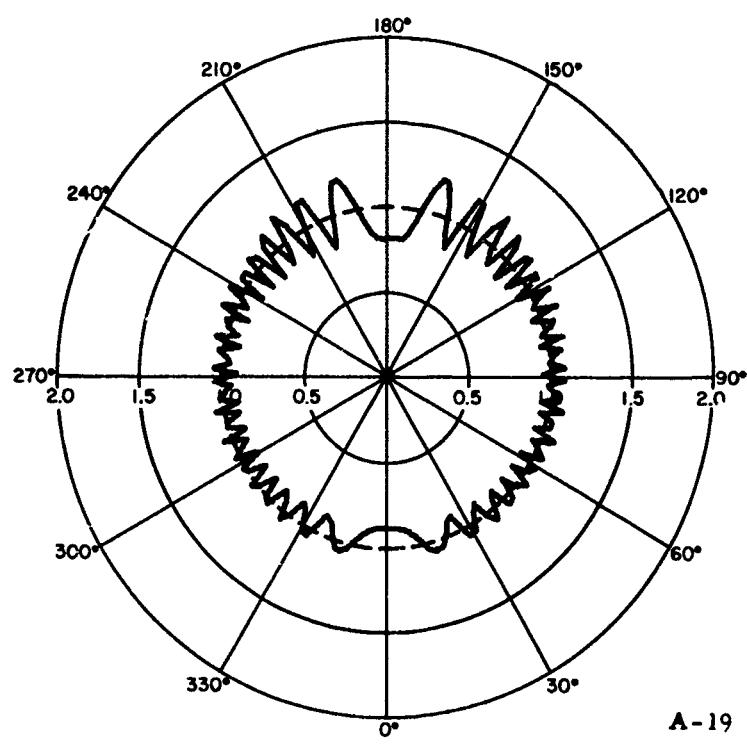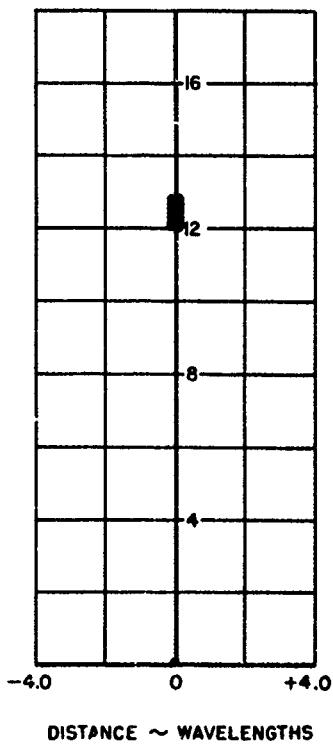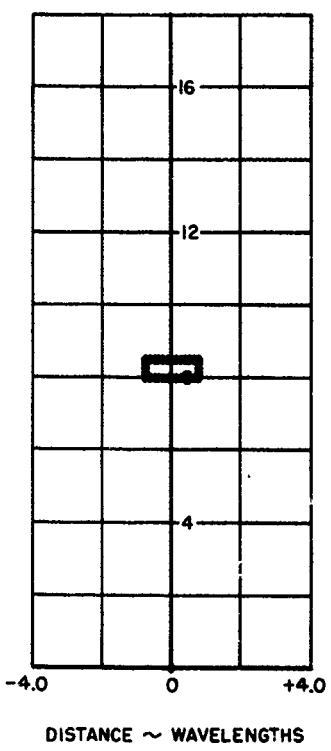
DISTANCE ~ WAVELENGTHS

A-22

DISTANCE ~ WAVELENGTHS

A-21

171

DISTANCE ~ WAVELENGTHS

A-24

DISTANCE ~ WAVELENGTHS

A-23

172
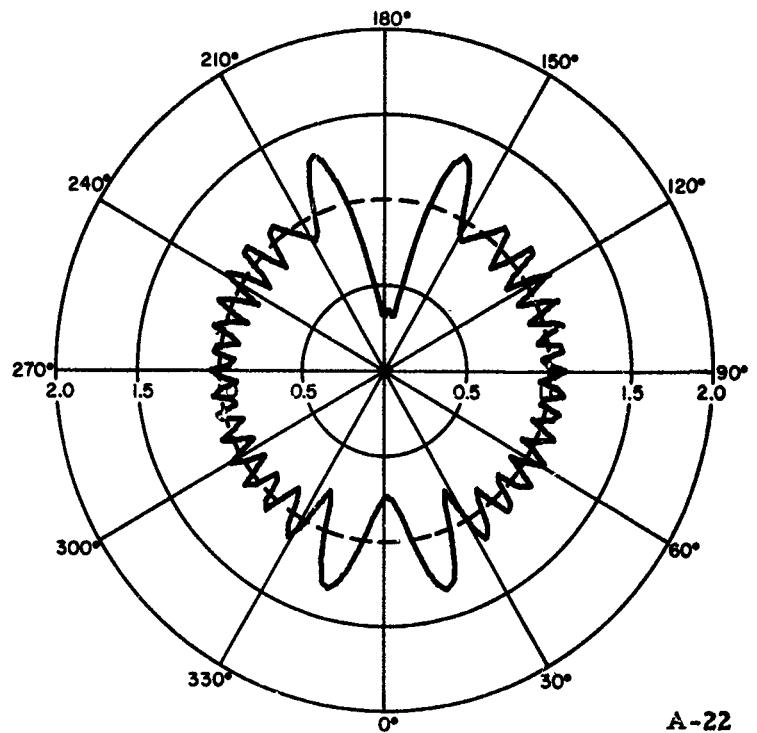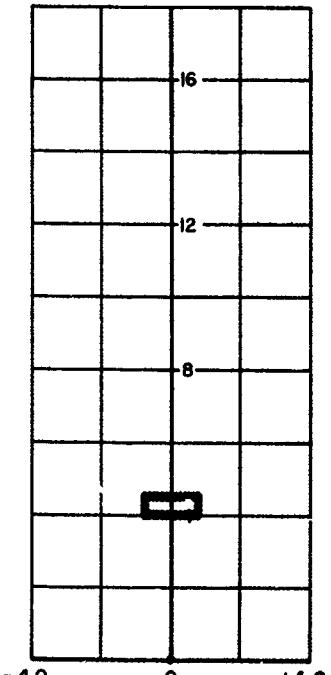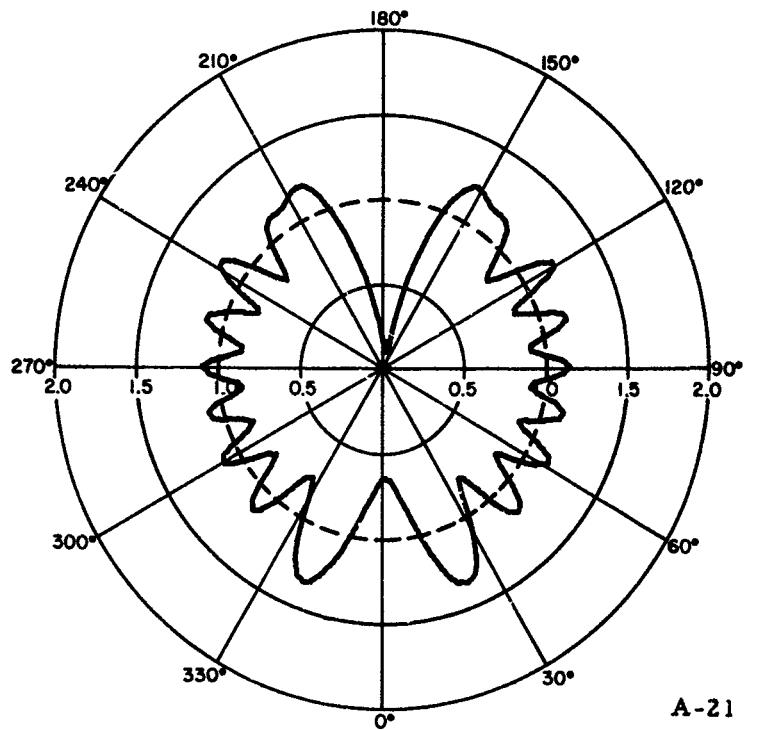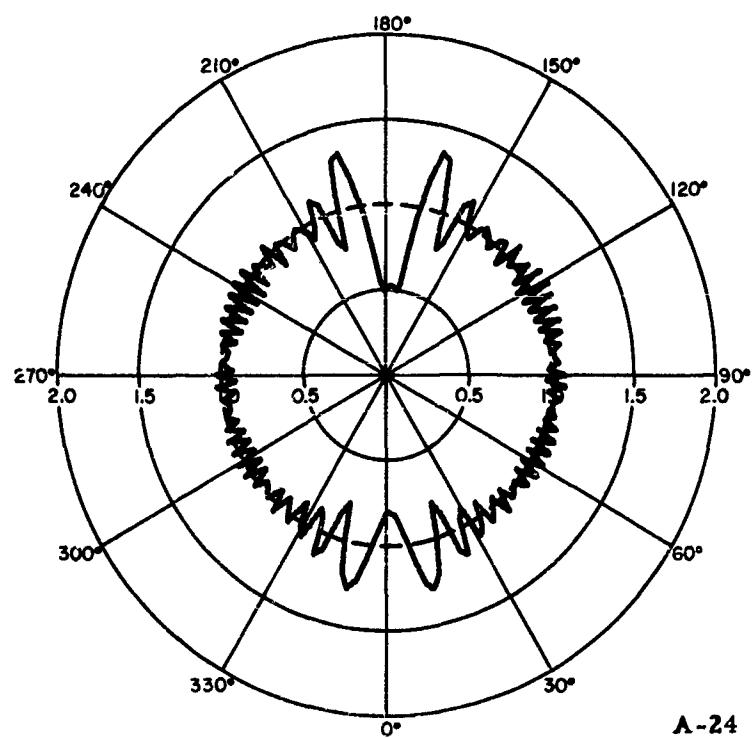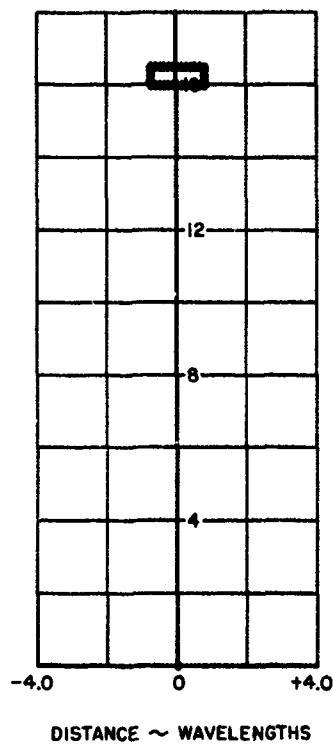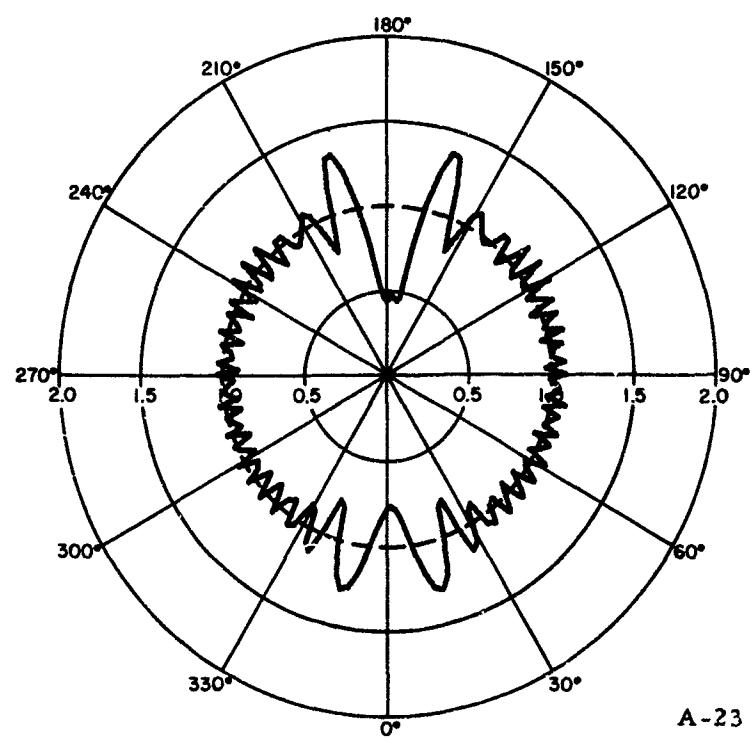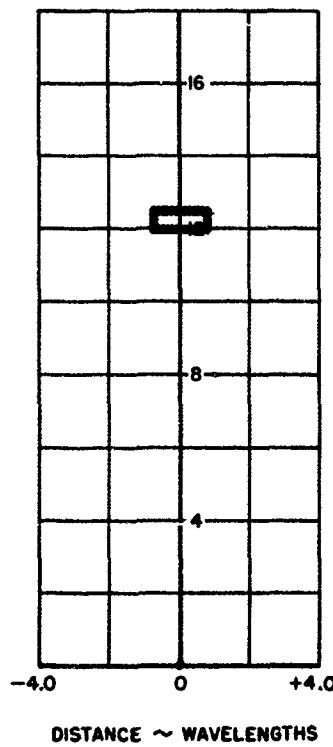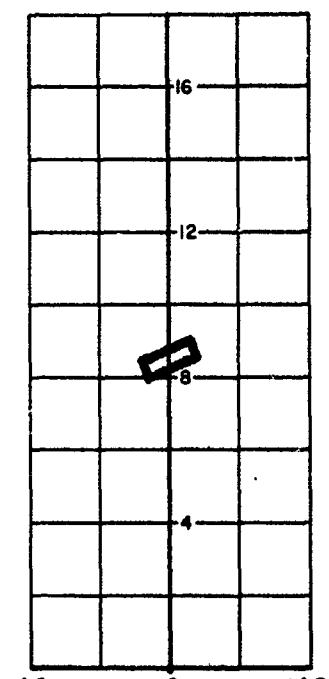
DISTANCE ~ WAVELENGTHS

A-26

DISTANCE ~ WAVELENGTHS

A-25

173

DISTANCE ~ WAVELENGTHS

A-28

DISTANCE ~ WAVELENGTHS

A-27

174

DISTANCE ~ WAVELENGTHS

A-30

DISTANCE ~ WAVELENGTHS

A-29

175

DISTANCE ~ WAVELENGTHS

A-32

DISTANCE ~ WAVELENGTHS

A-31

176

DISTANCE ~ WAVELENGTHS

A-34

DISTANCE ~ WAVELENGTHS

A-33

177

DISTANCE ~ WAVELENGTHS

A-36

DISTANCE ~ WAVELENGTHS

A-35

178

DISTANCE ~ WAVELENGTHS

A-38

DISTANCE ~ WAVELENGTHS

A-37

179
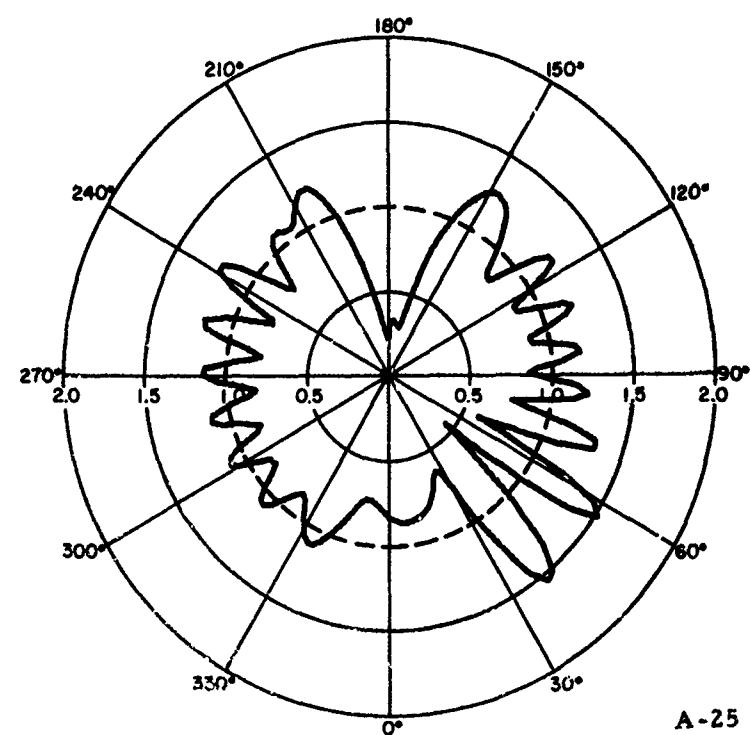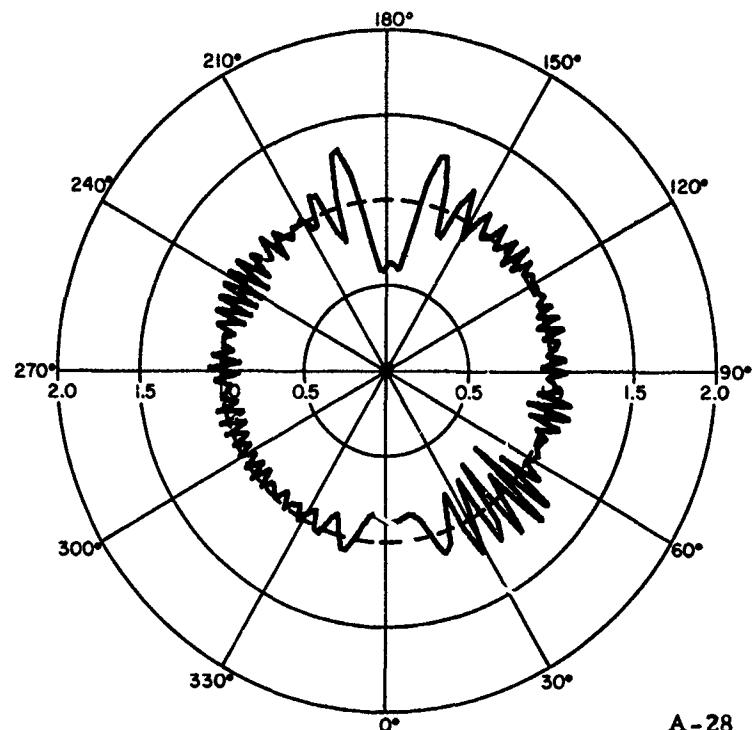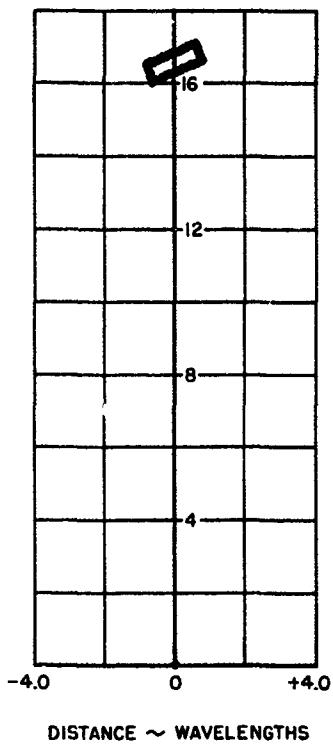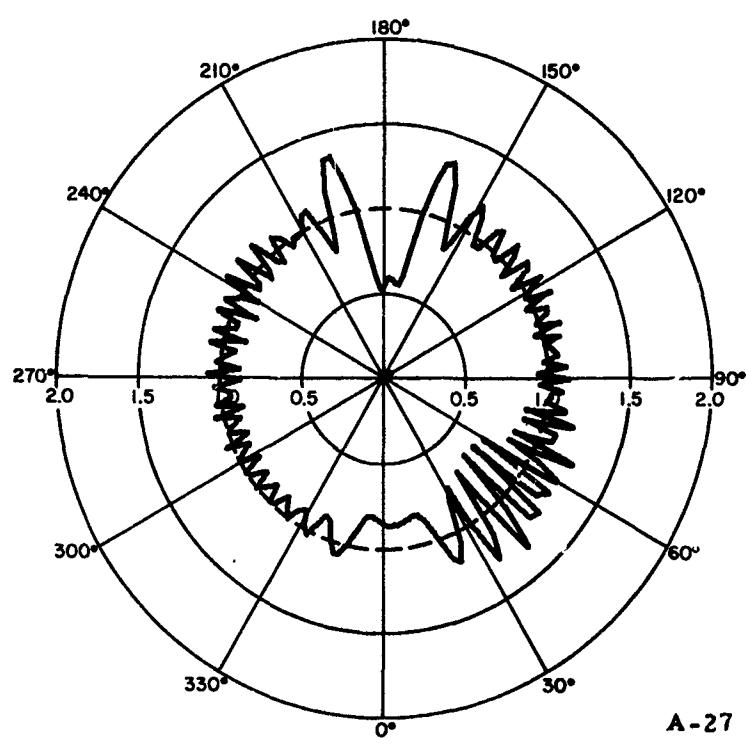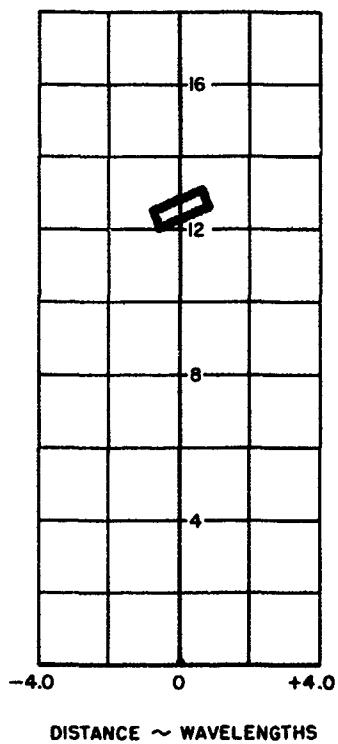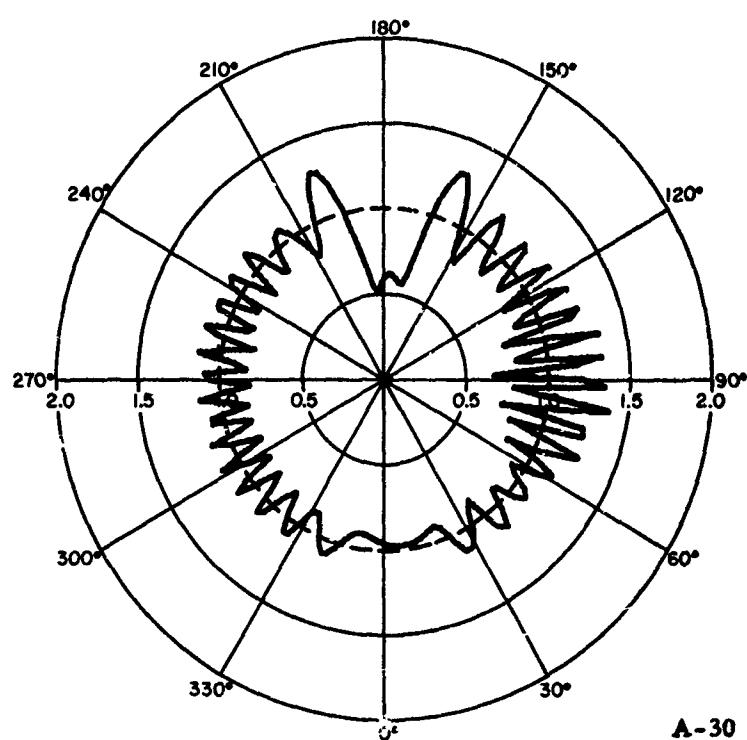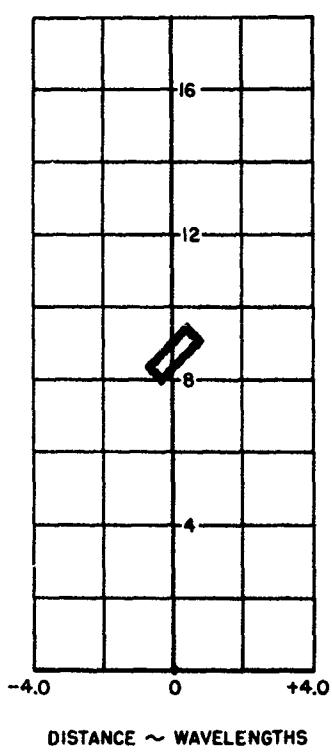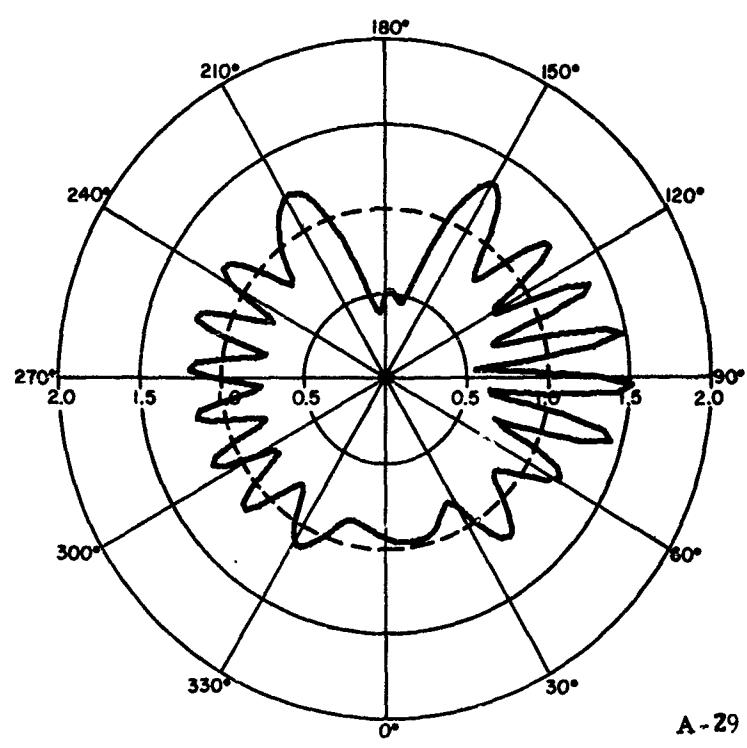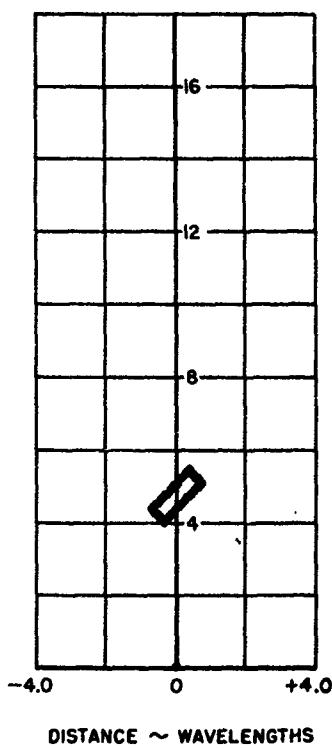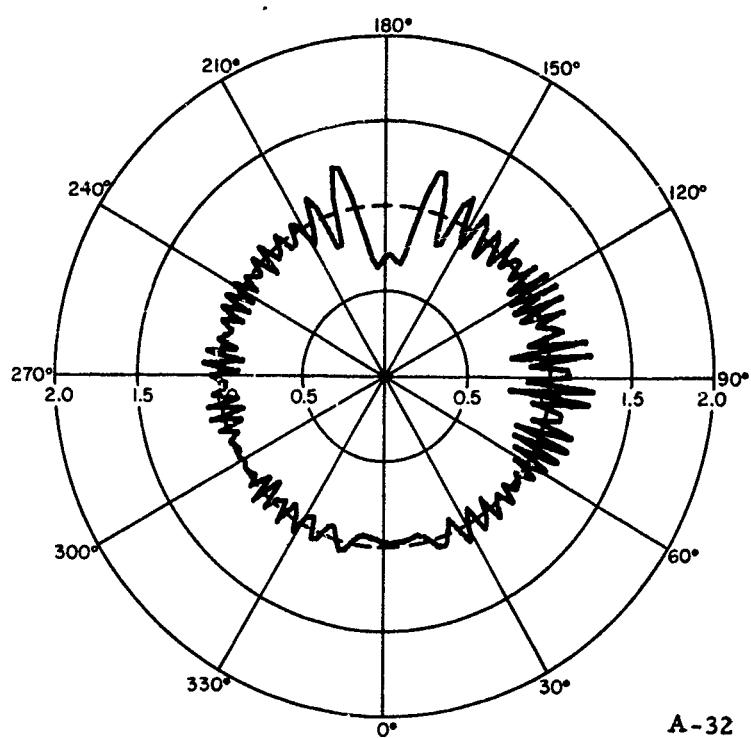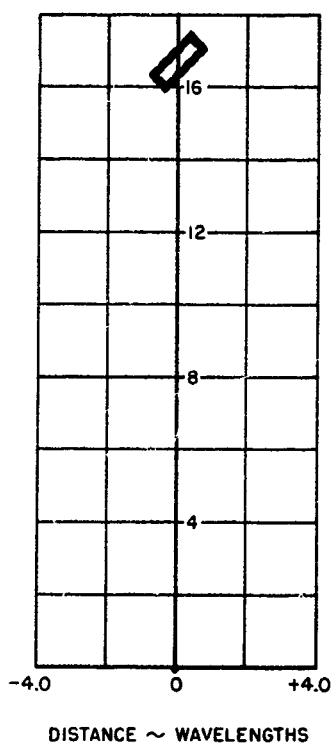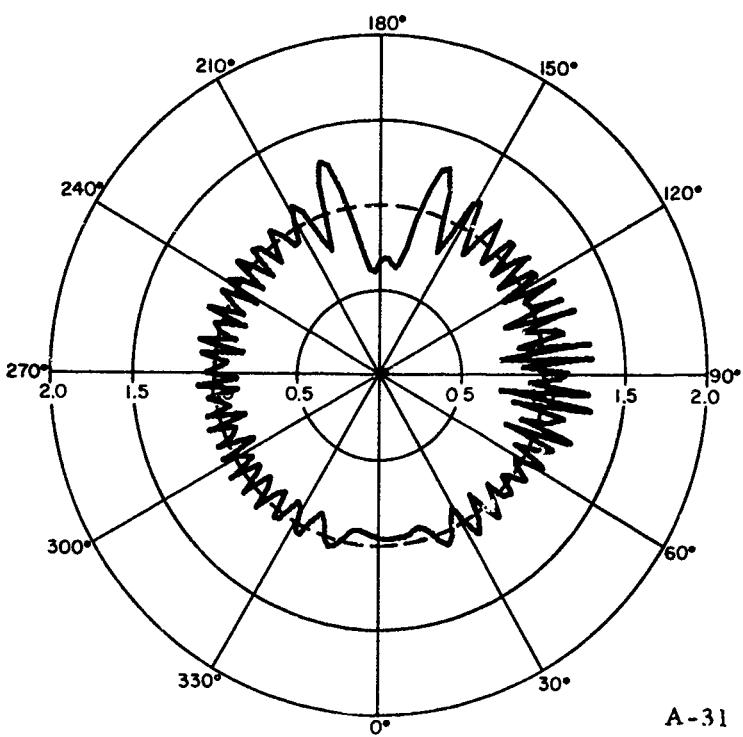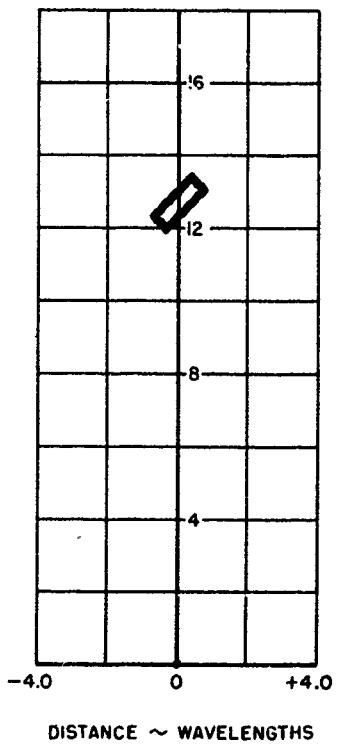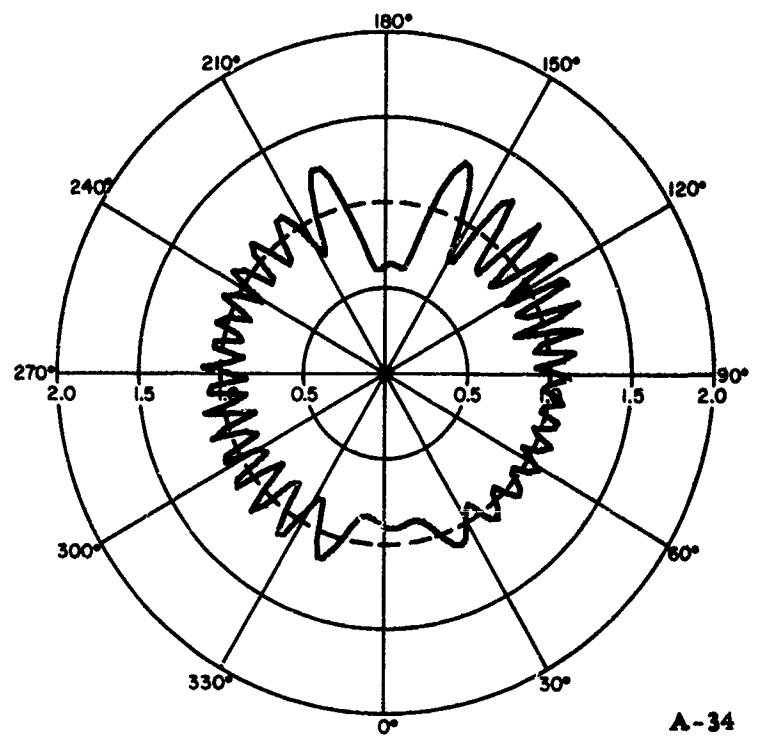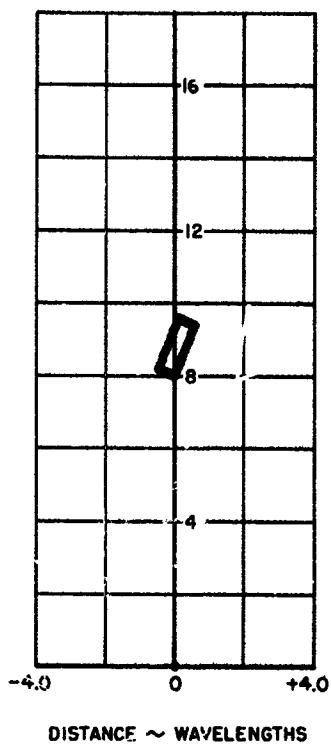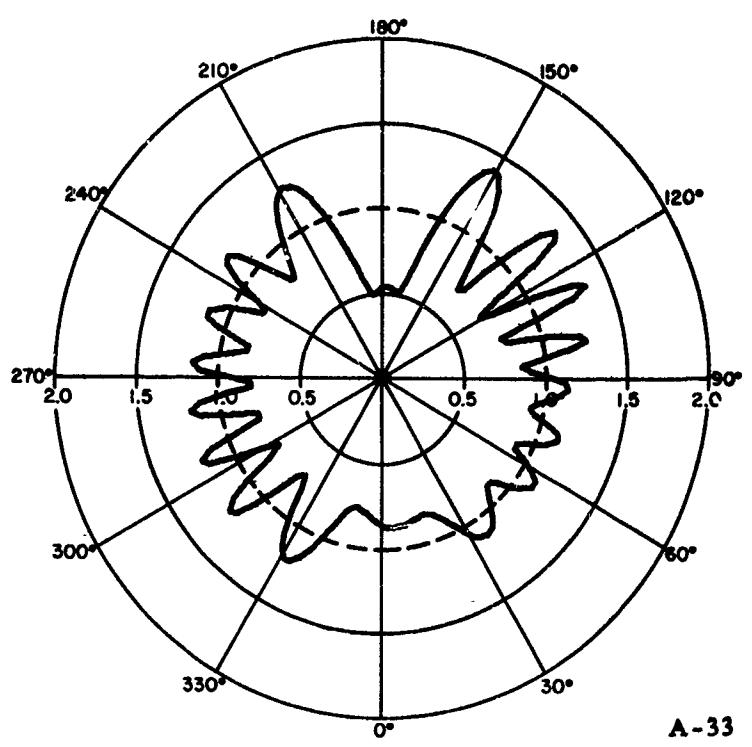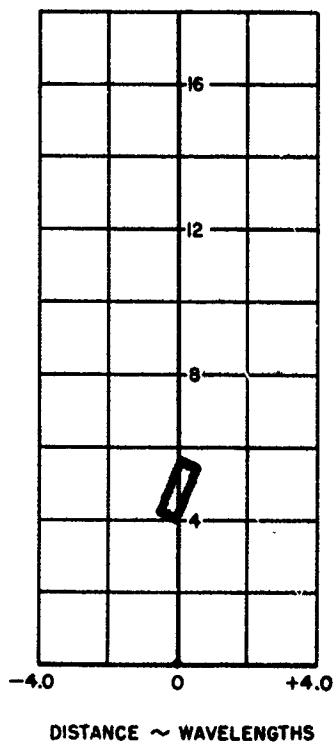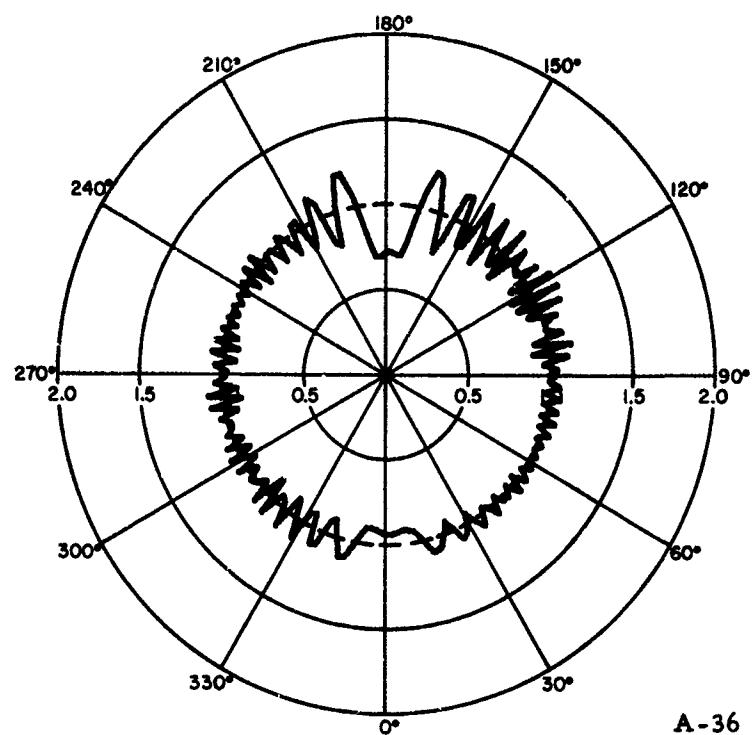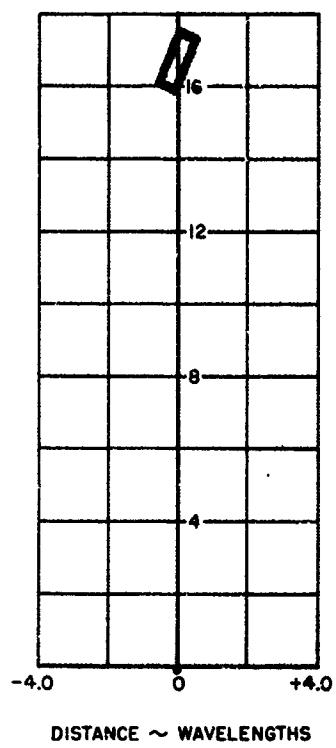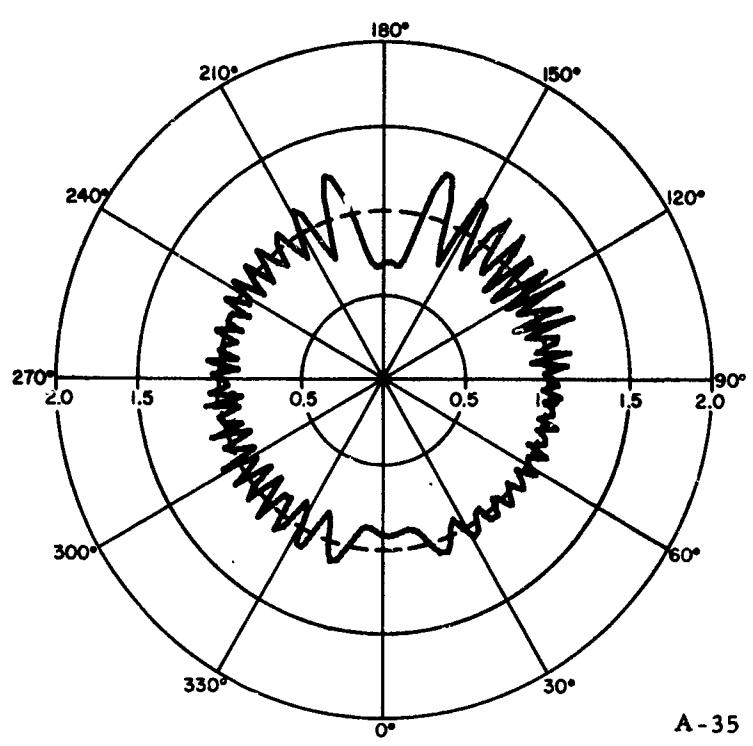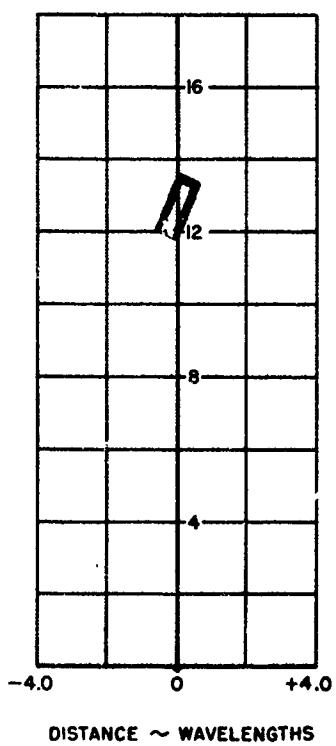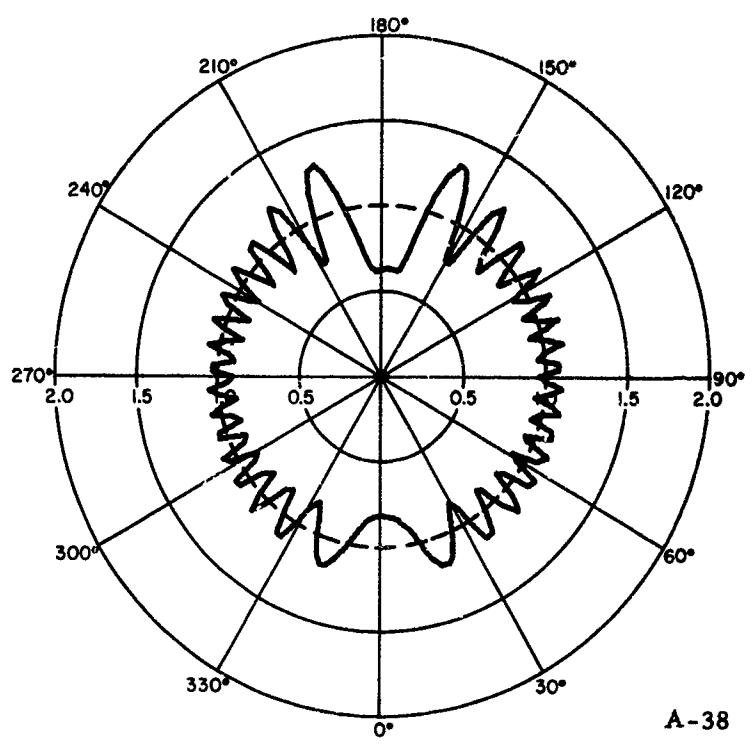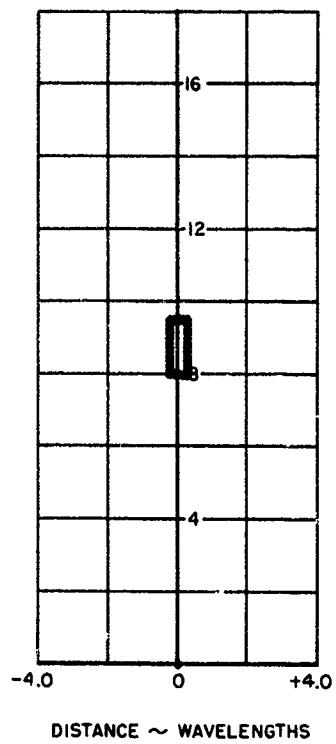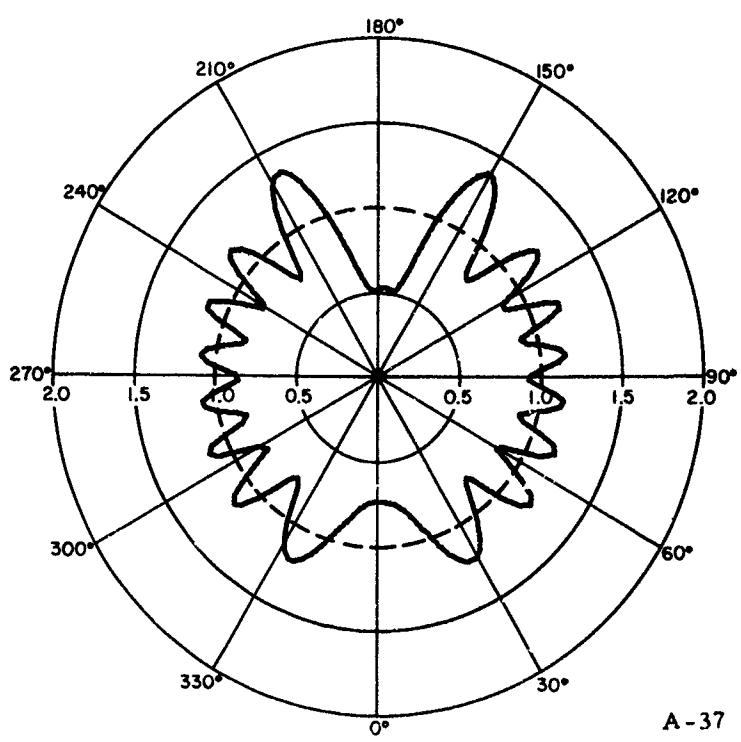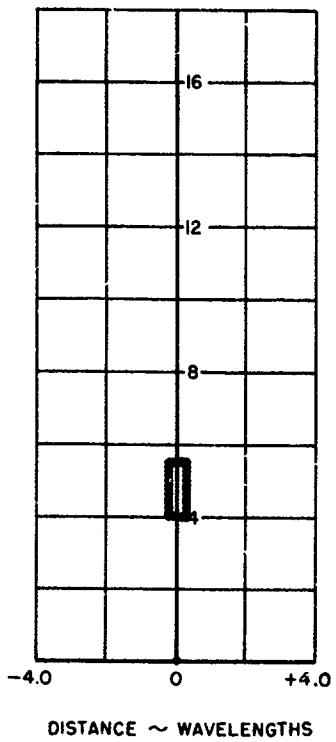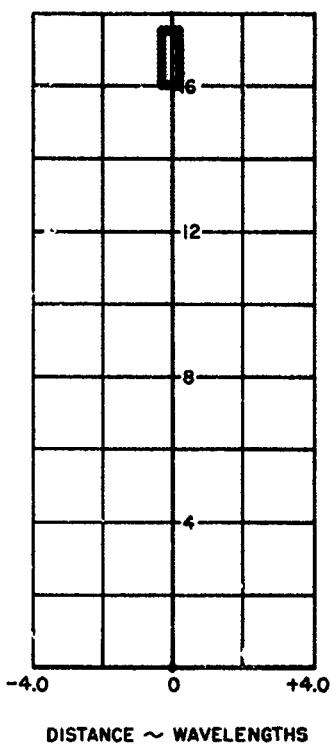
DISTANCE ~ WAVELENGTHS

A-40

DISTANCE ~ WAVELENGTHS

A-39

180

DISTANCE ~ WAVELENGTHS

A-42

DISTANCE ~ WAVELENGTHS

A-41

181
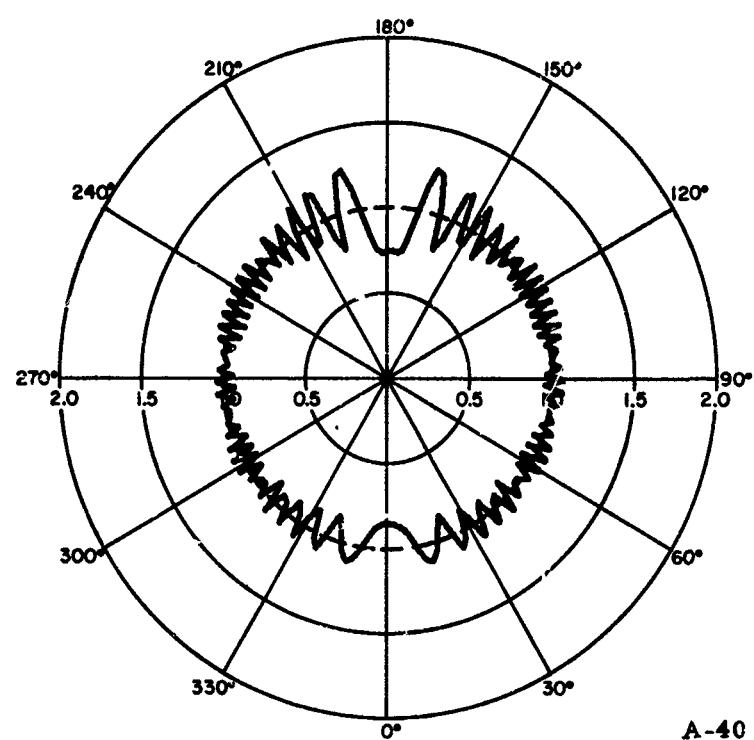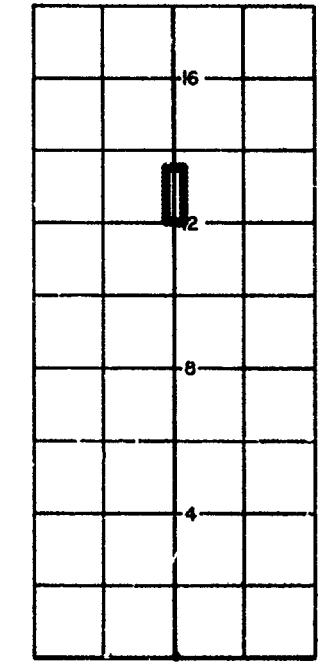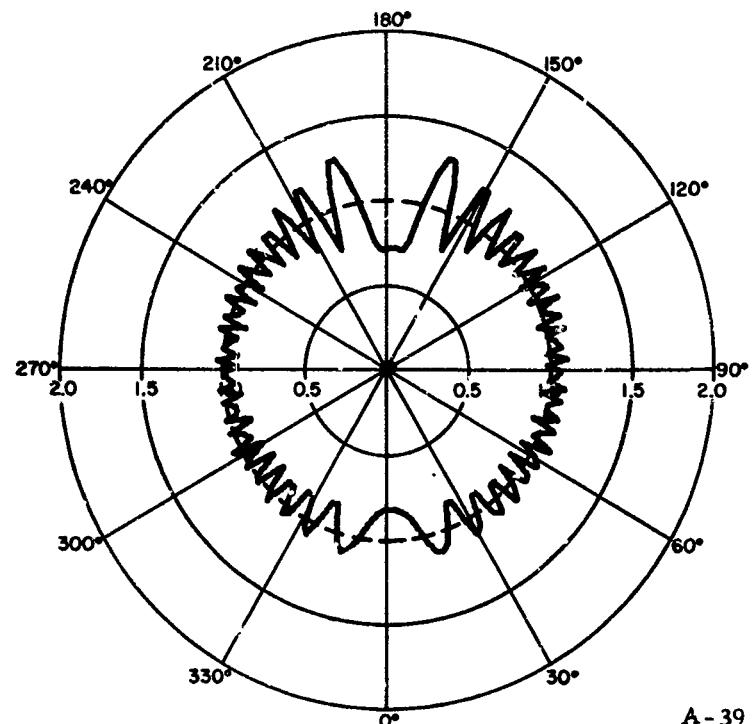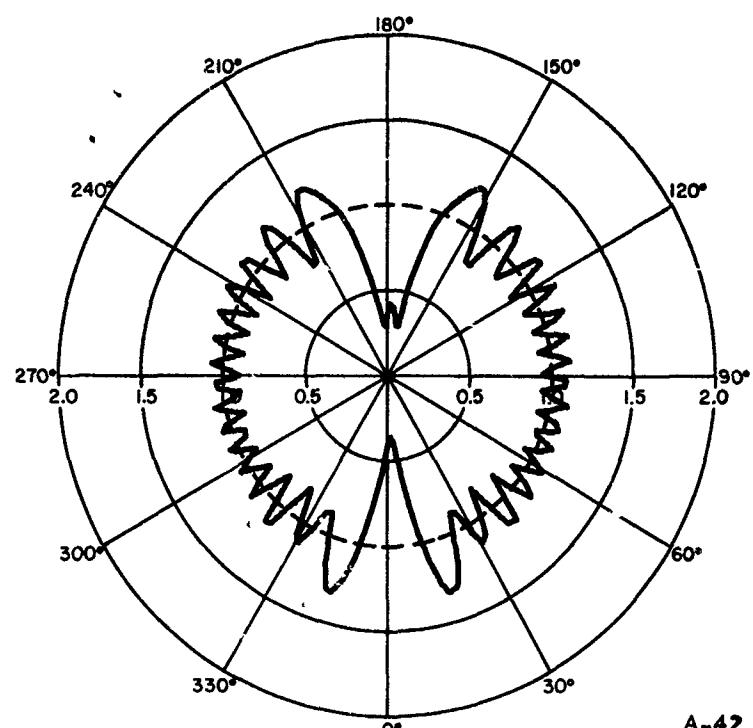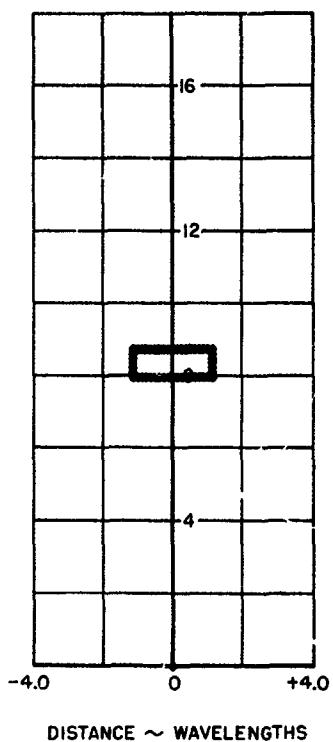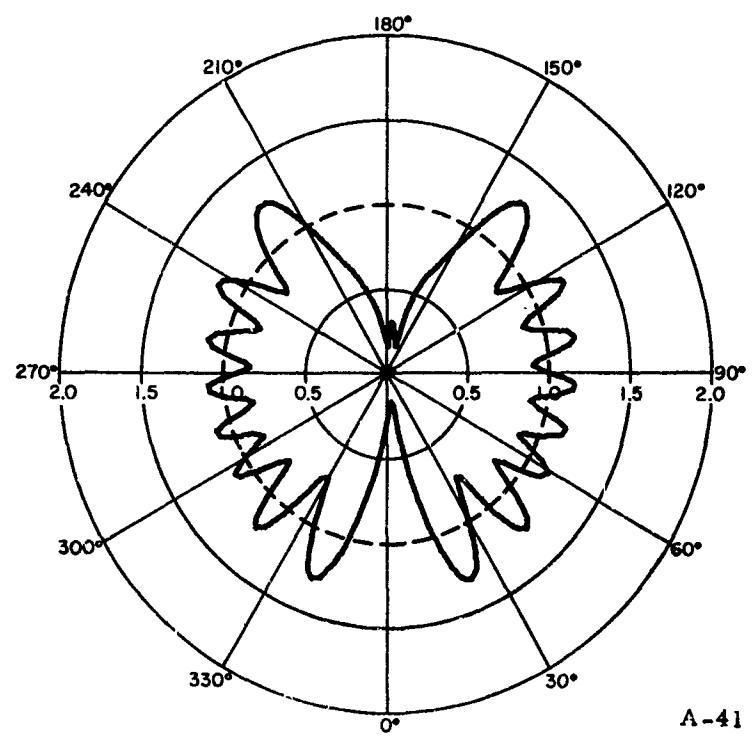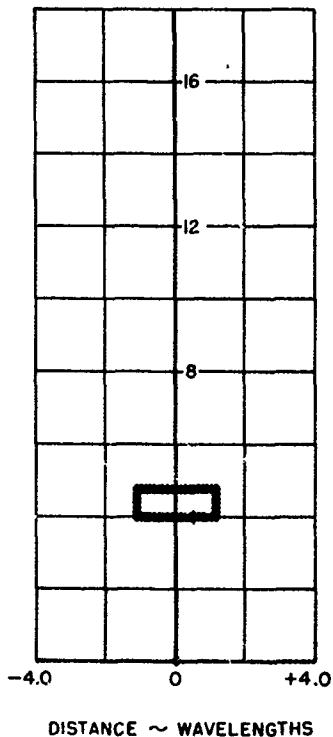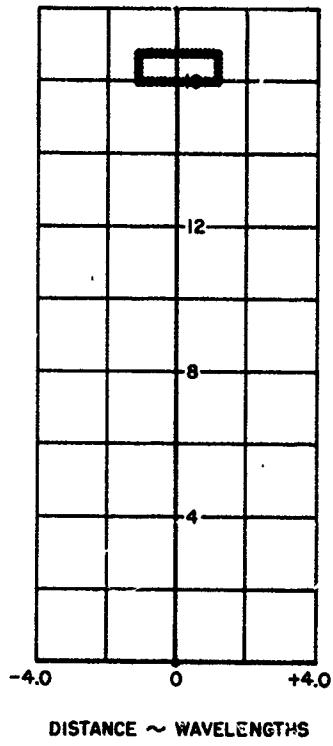
DISTANCE ~ WAVELENGTHS

A-44

DISTANCE ~ WAVELENGTHS

A-43

DISTANCE ~ WAVELENGTHS

A-46

DISTANCE ~ WAVELENGTHS

A-45

183
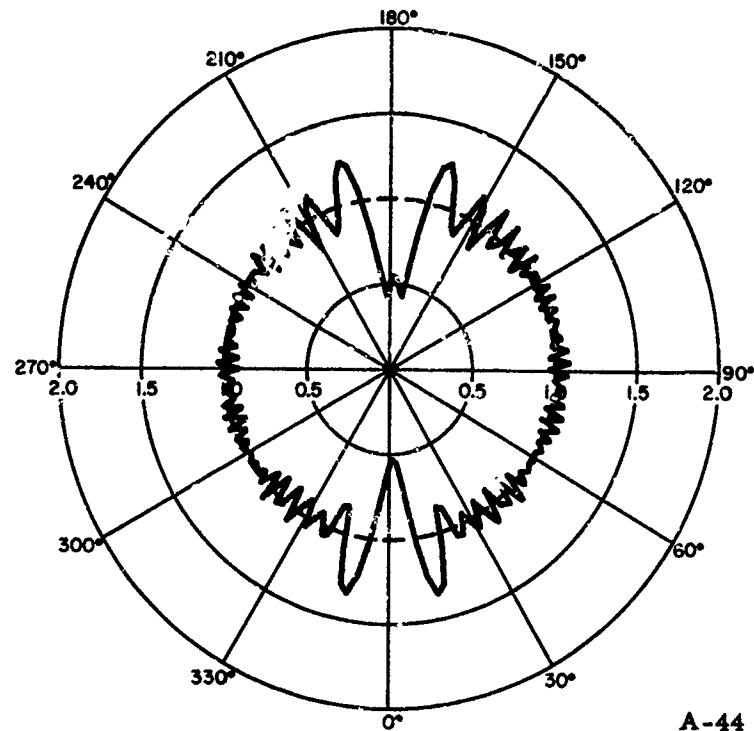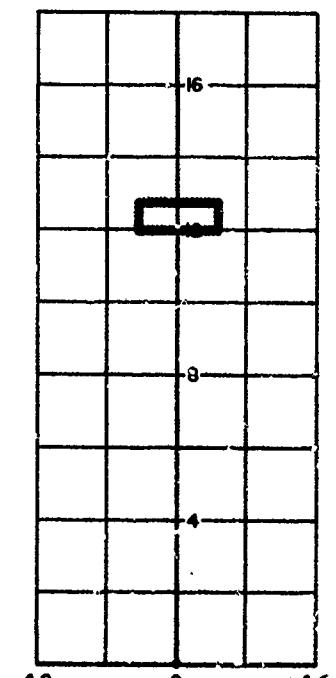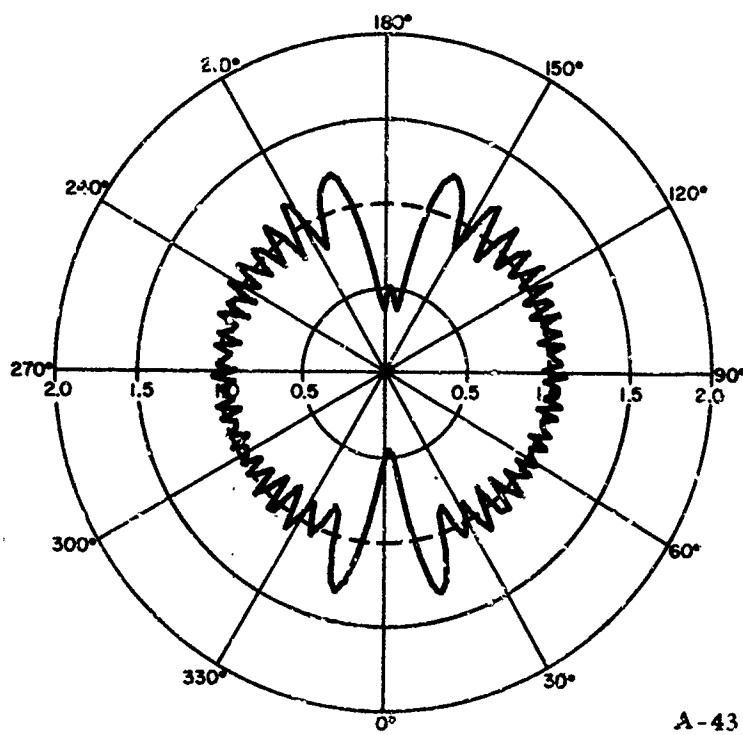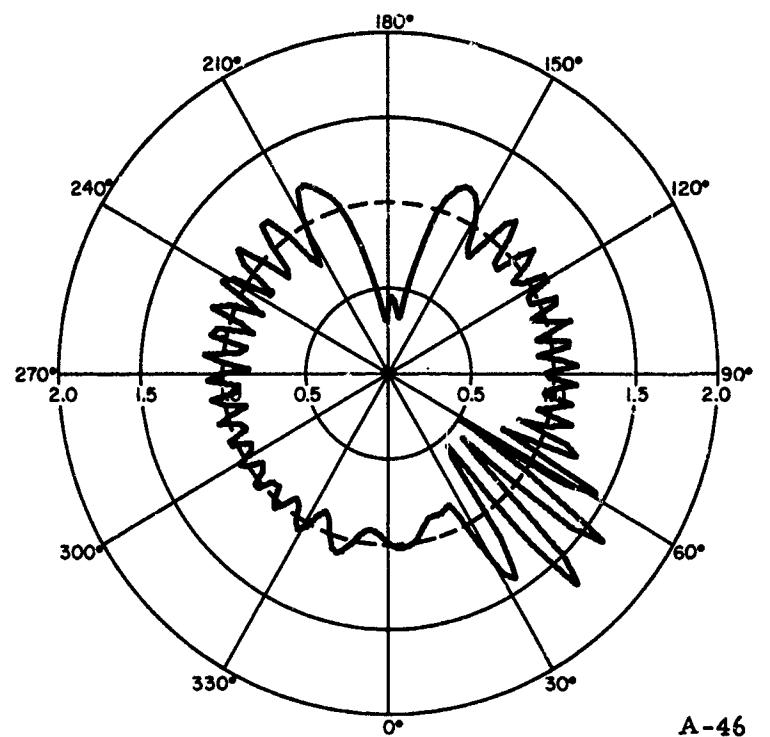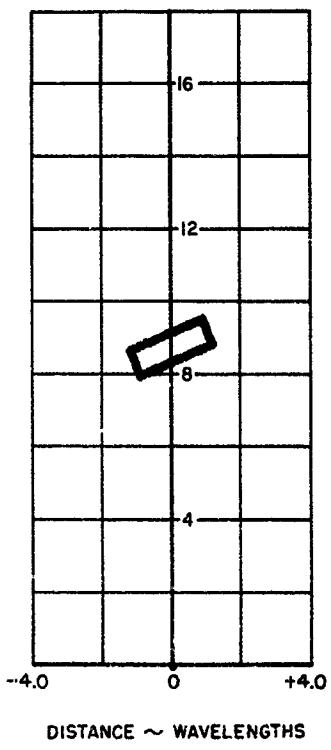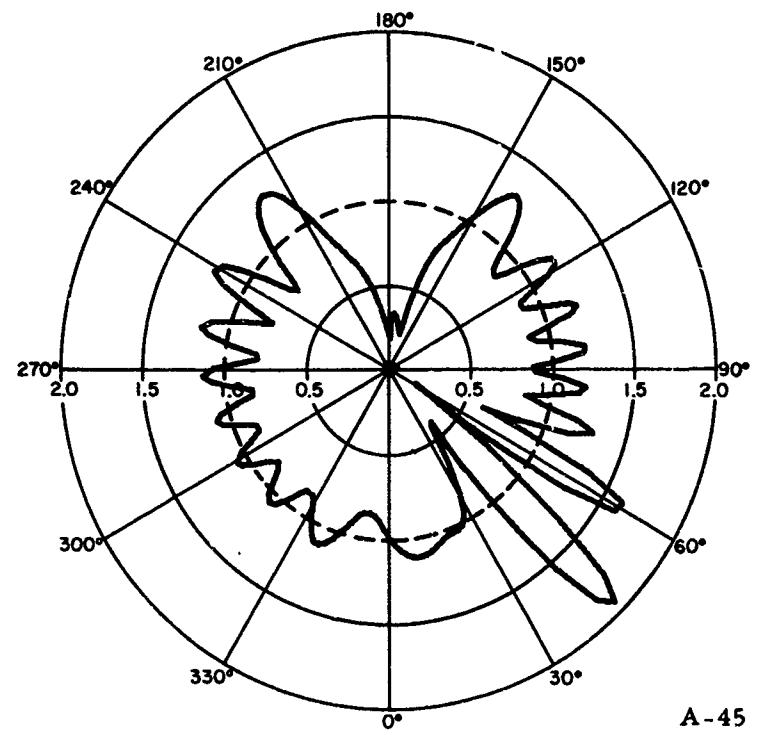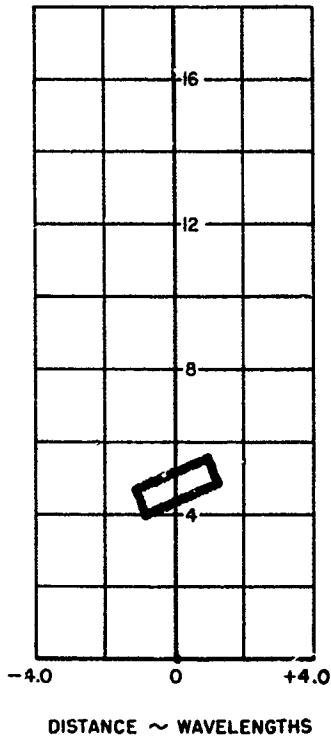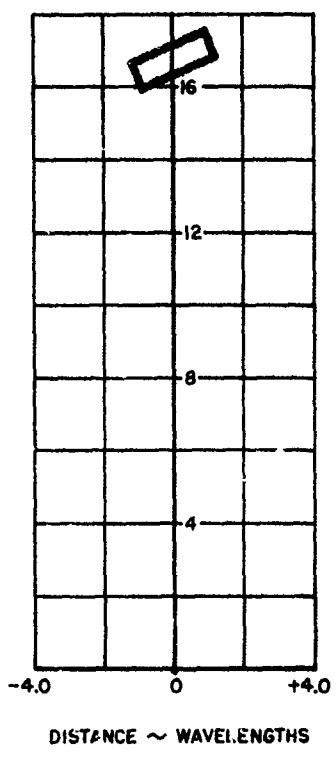
DISTANCE ~ WAVELENGTHS

A-48

DISTANCE ~ WAVELENGTHS

A-47

184

DISTANCE ∼ WAVELENGTHS

A-50

DISTANCE ∼ WAVELENGTHS

A-49

185

DISTANCE ~ WAVELENGTHS

A-52

DISTANCE ~ WAVELENGTHS

A-51

186

DISTANCE ~ WAVELENGTHS

A-54

DISTANCE ~ WAVELENGTHS

A-53

187

DISTANCE ~ WAVELENGTHS

A-56

DISTANCE ~ WAVELENGTHS

A-55

188

DISTANCE ~ WAVELENGTHS

A-58

DISTANCE ~ WAVELENGTHS

A-57

189
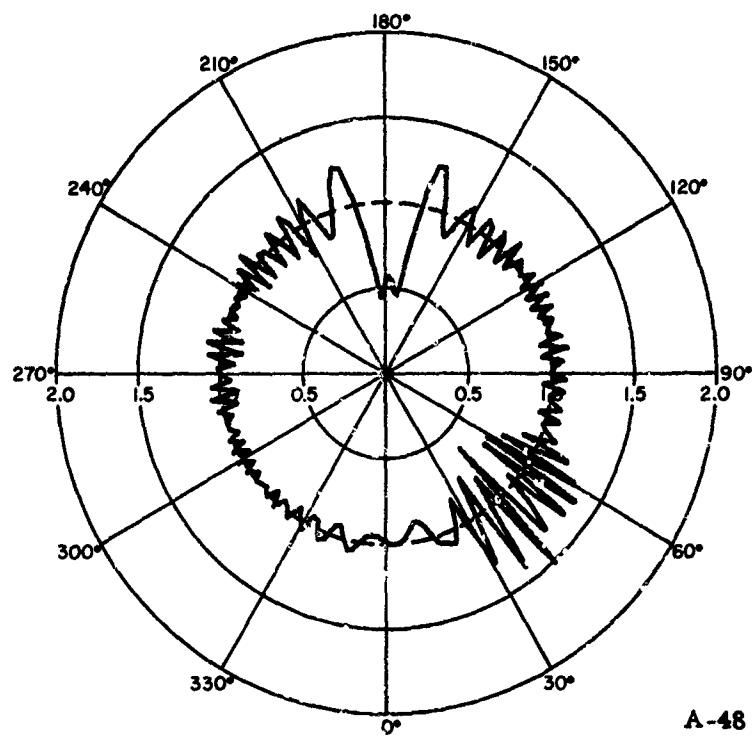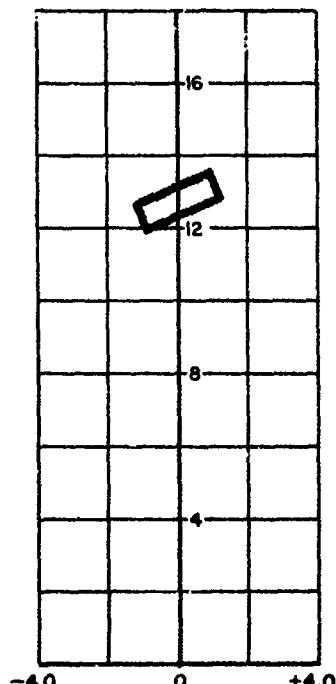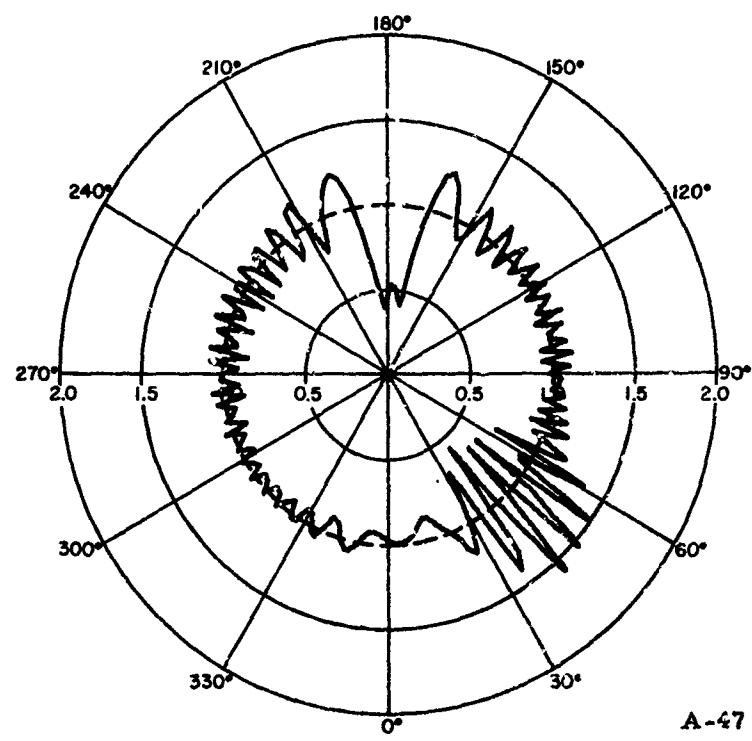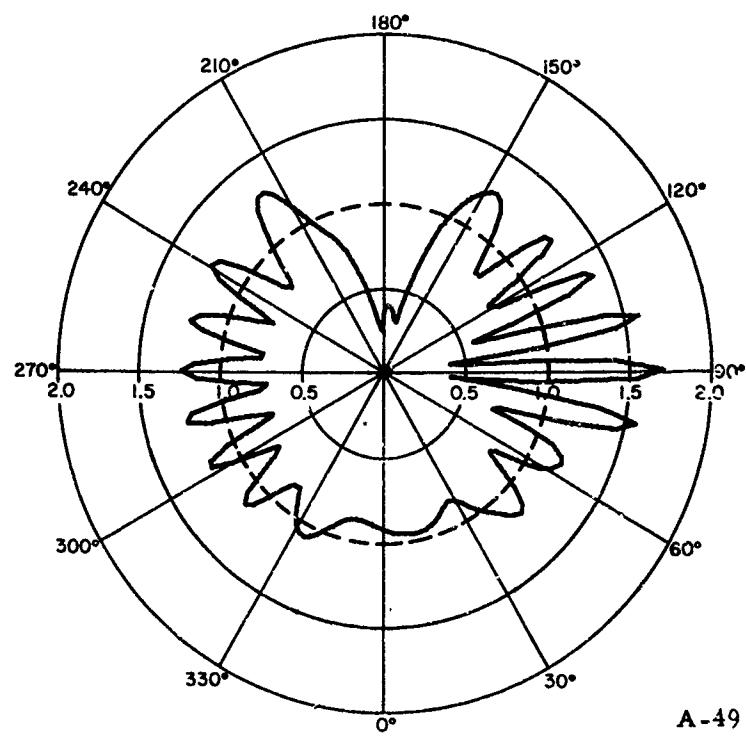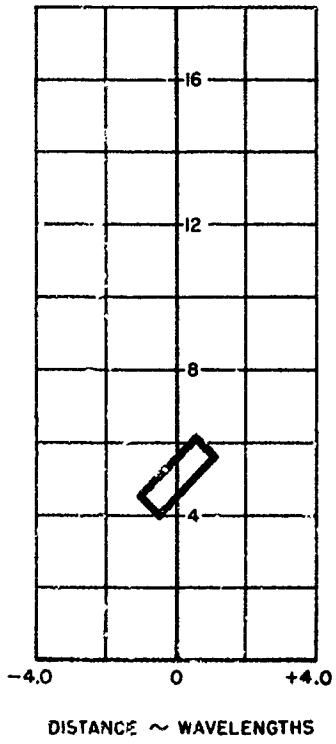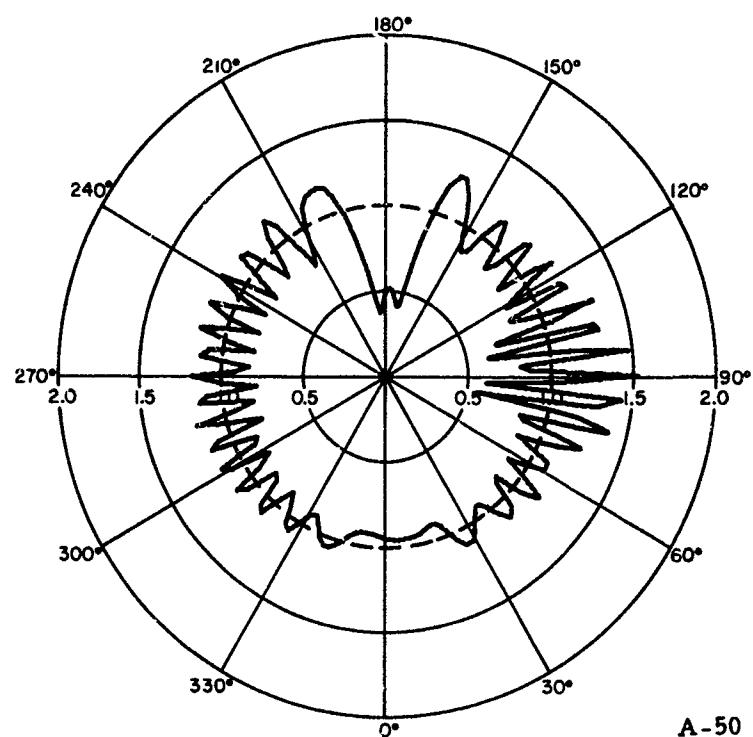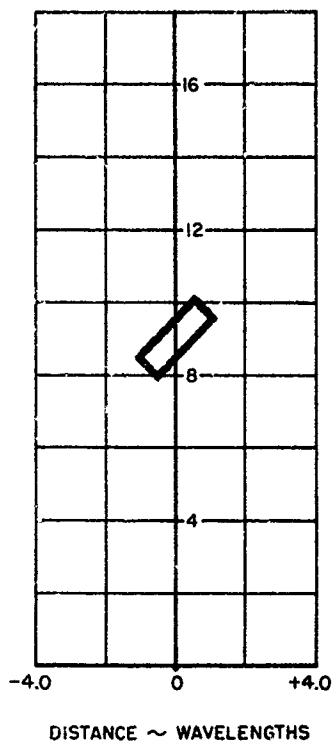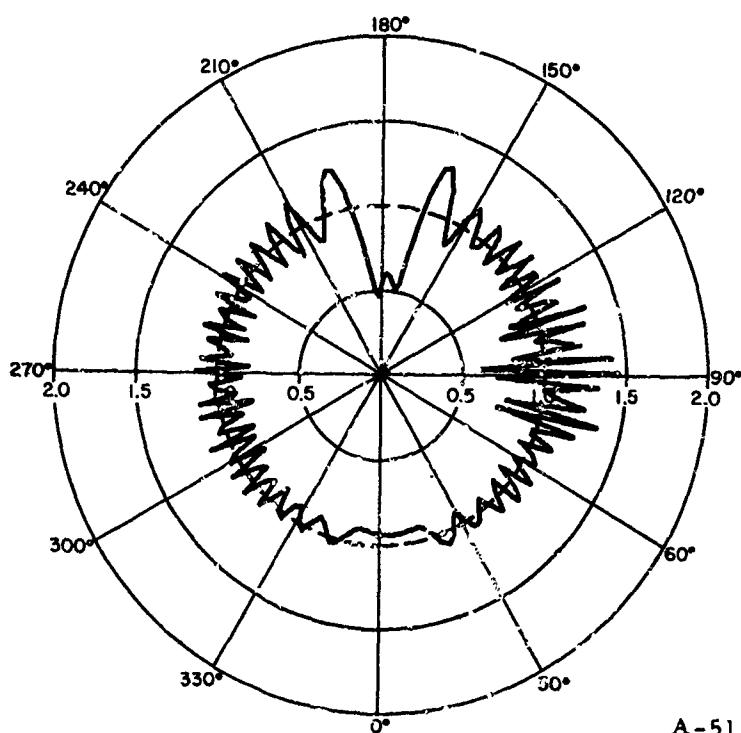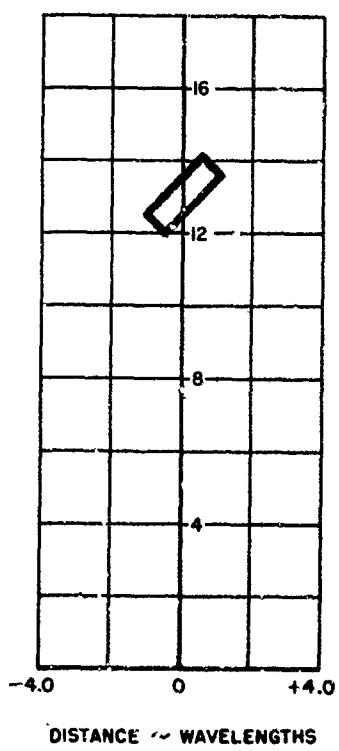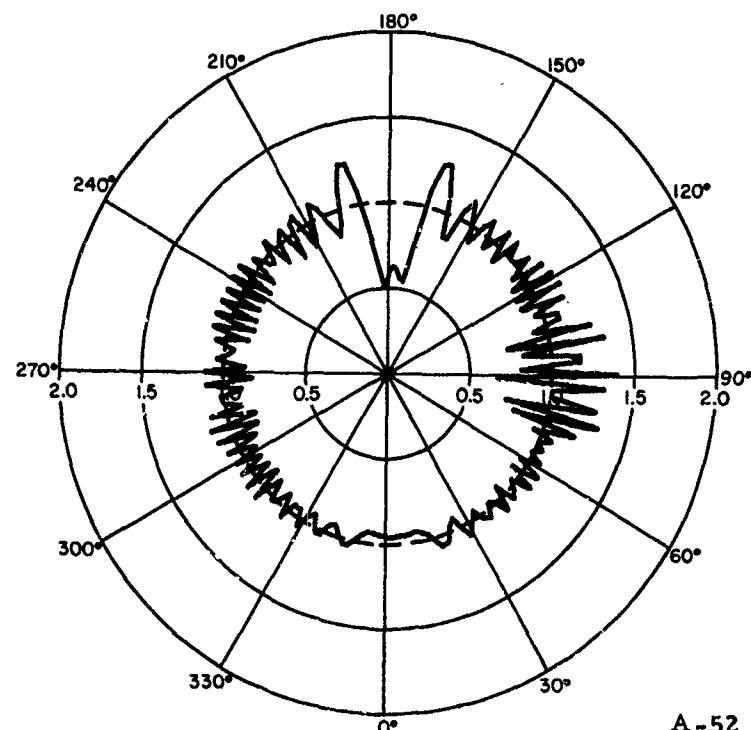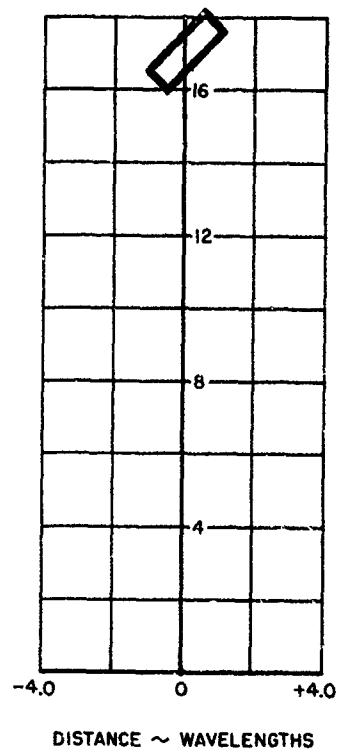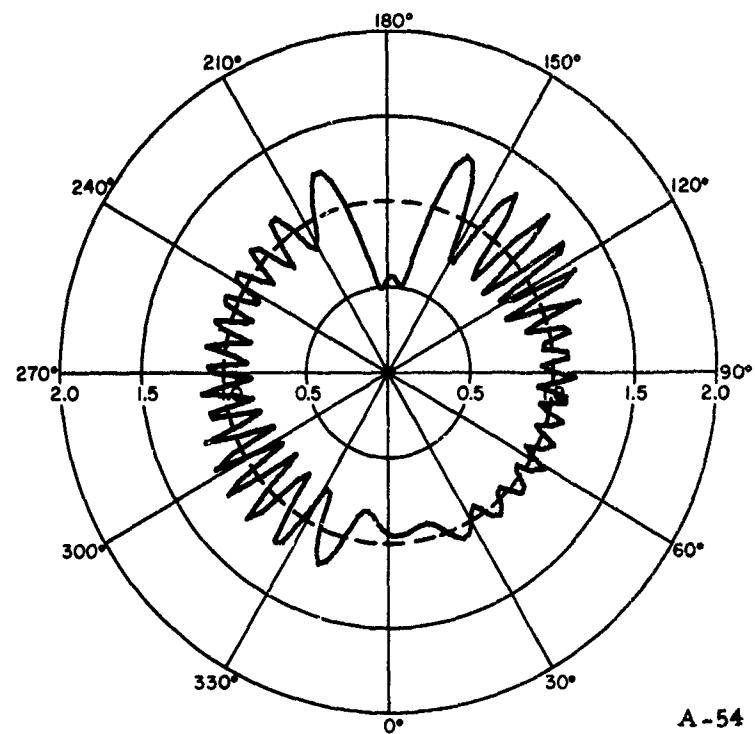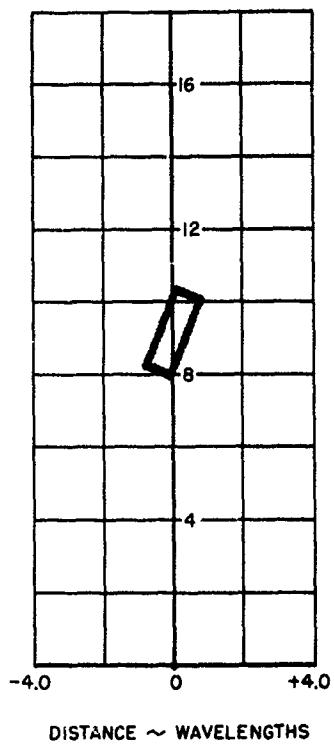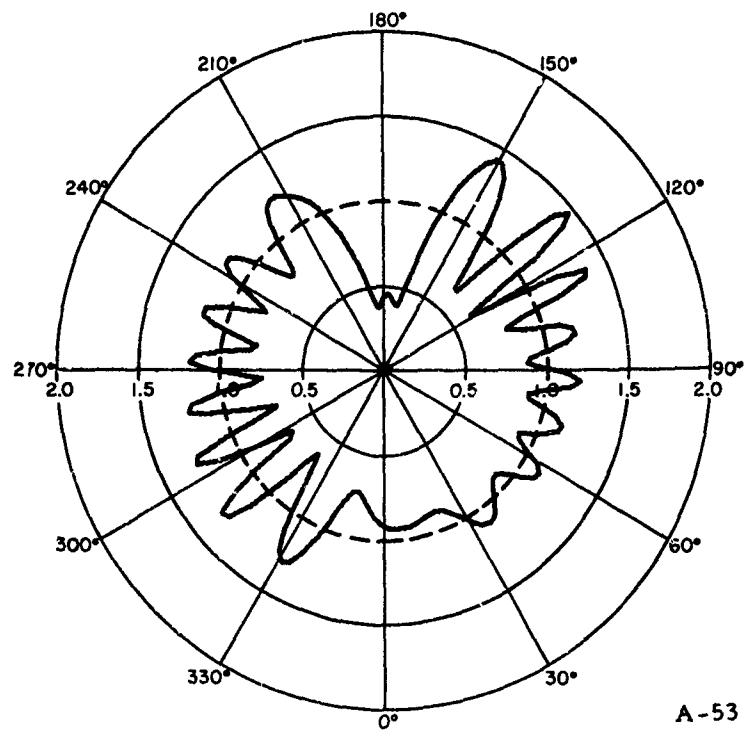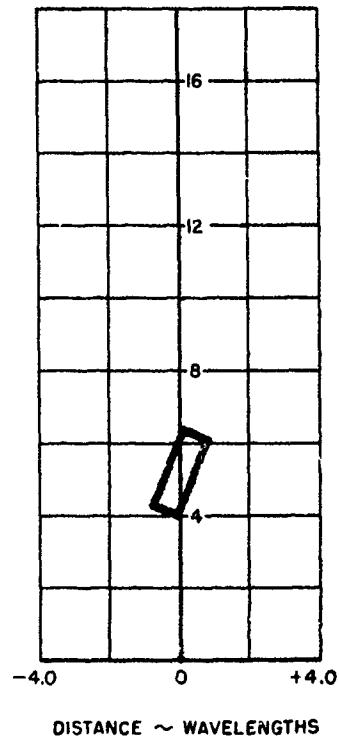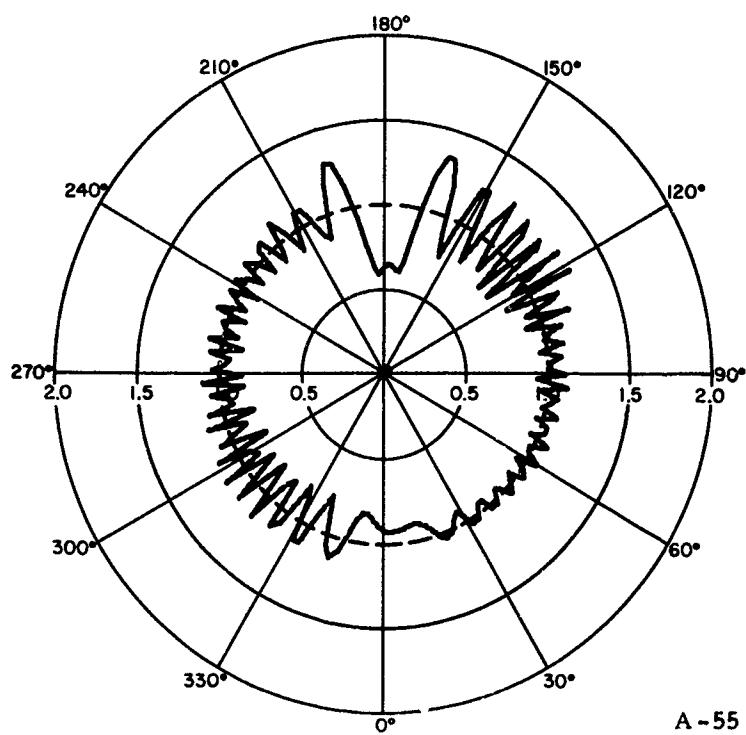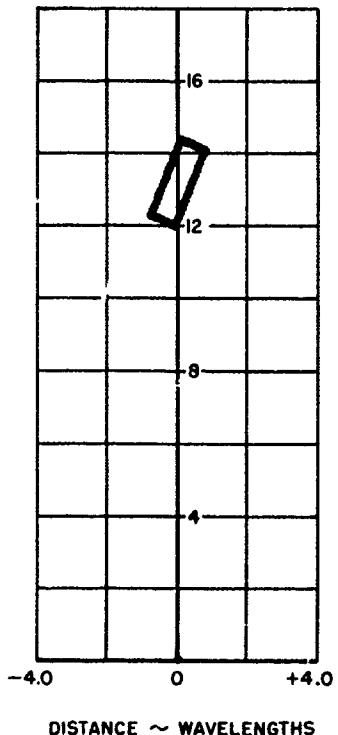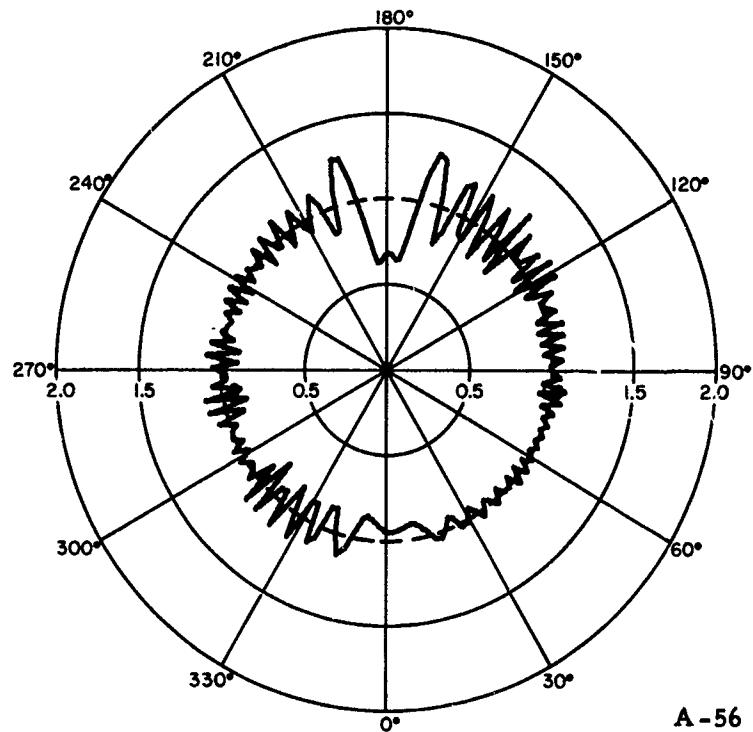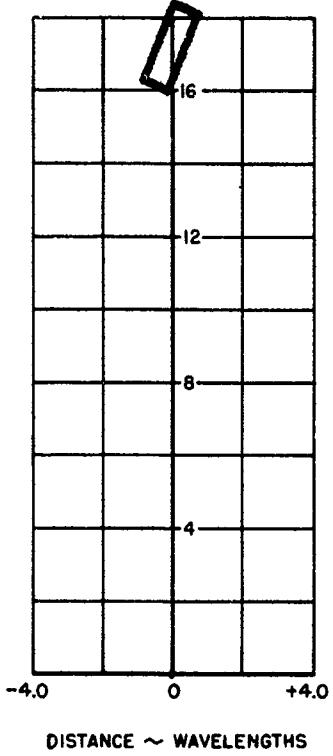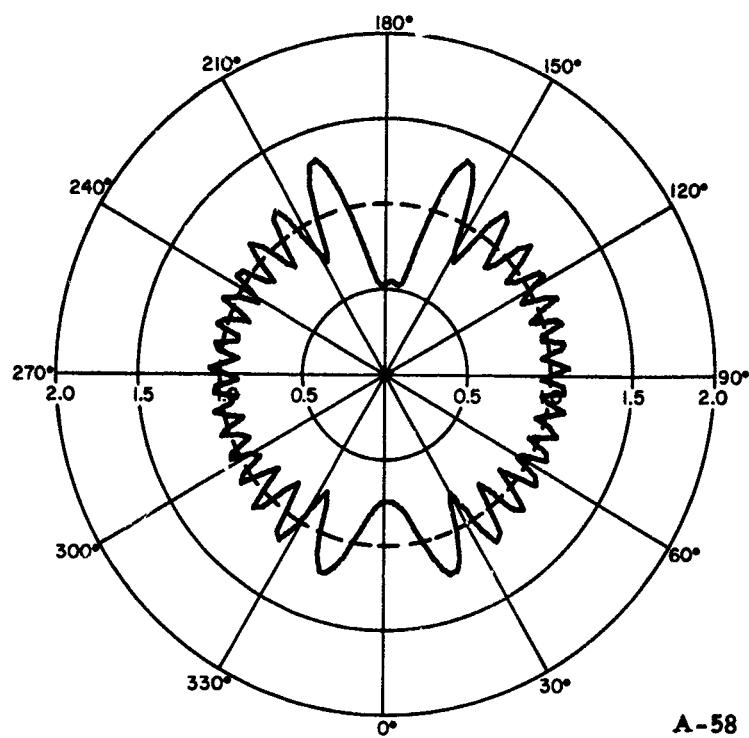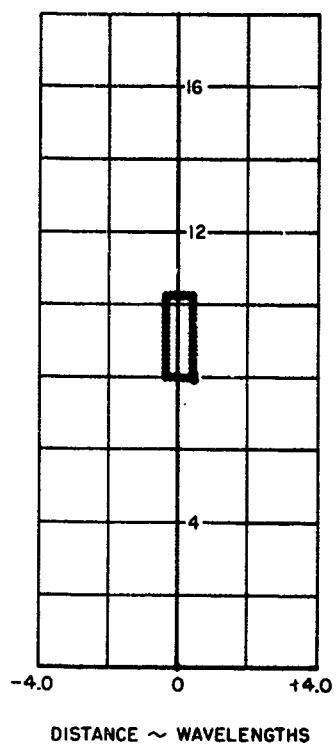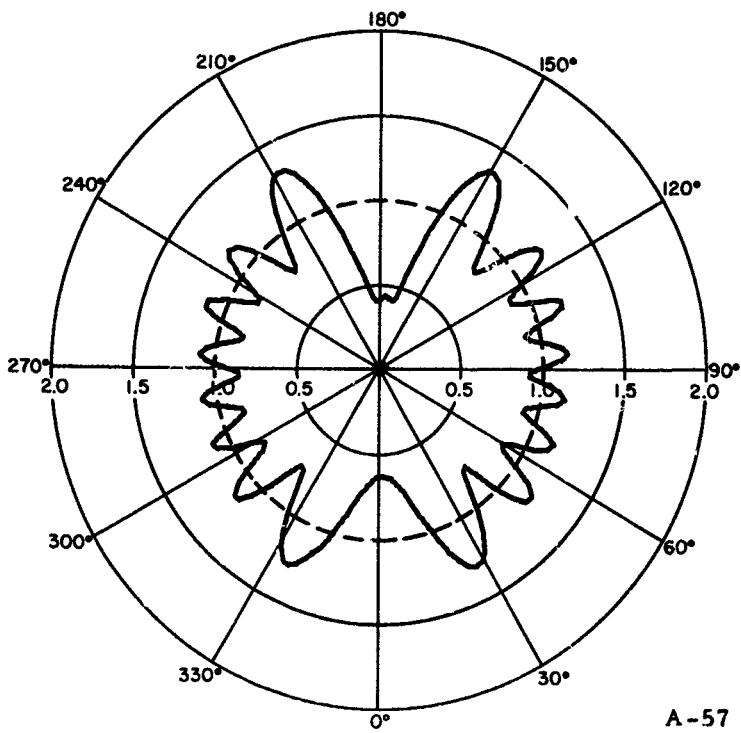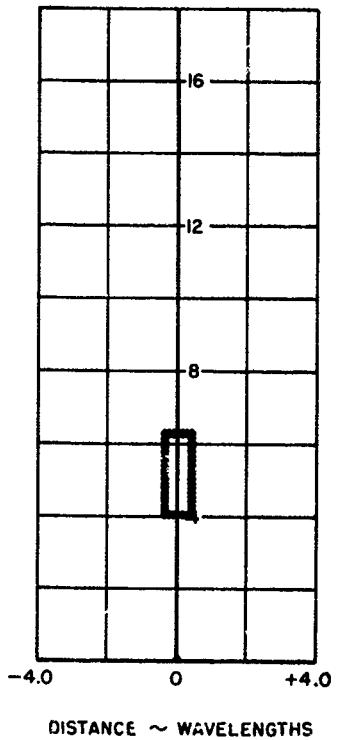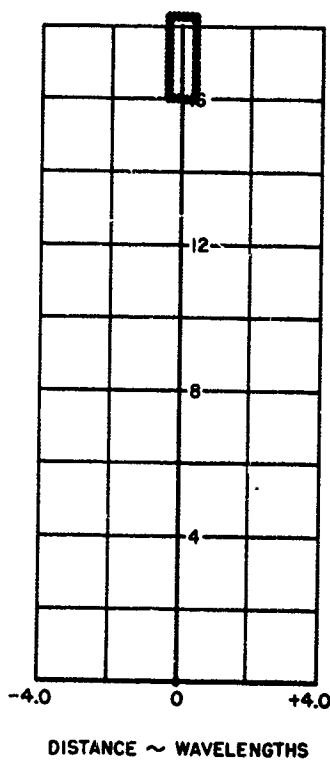
DISTANCE ~ WAVELENGTHS

A-60

DISTANCE ~ WAVELENGTHS
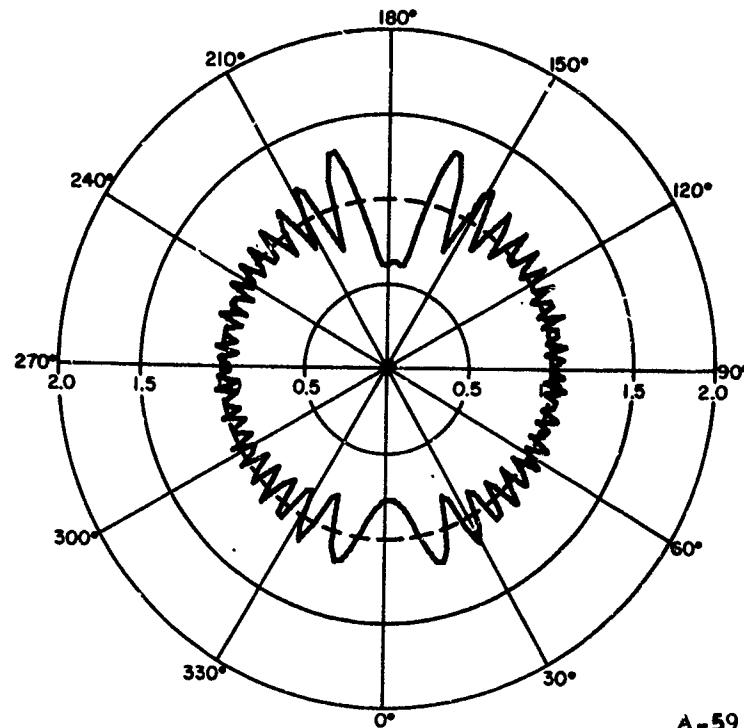
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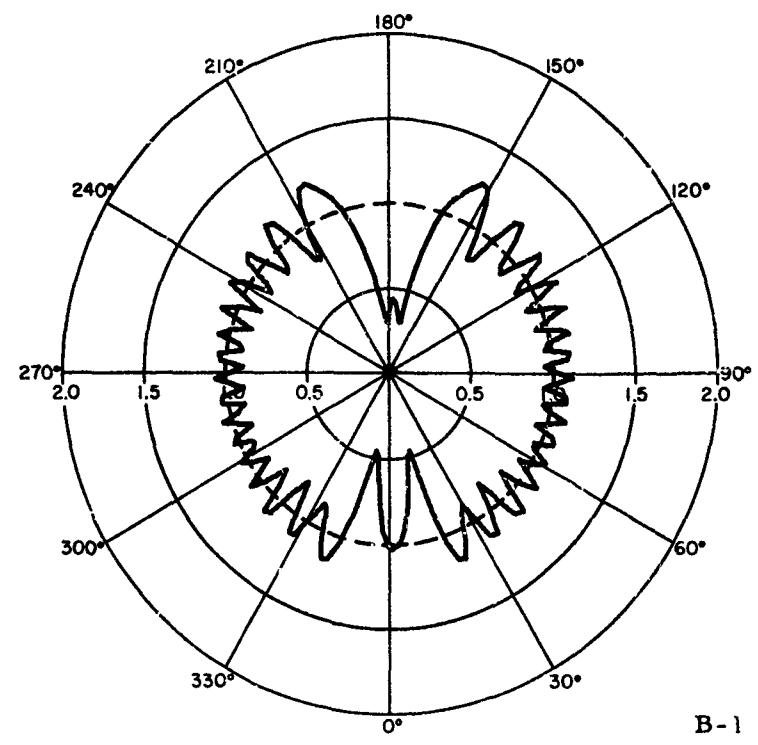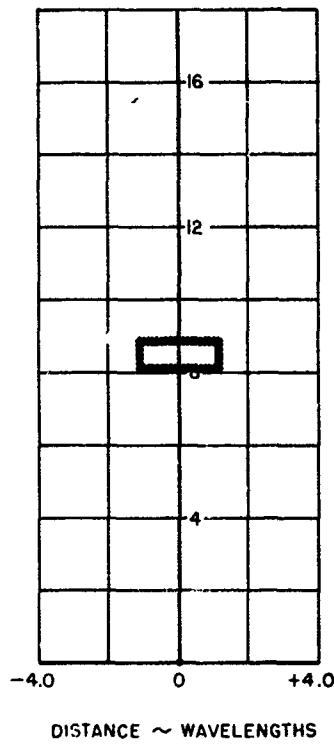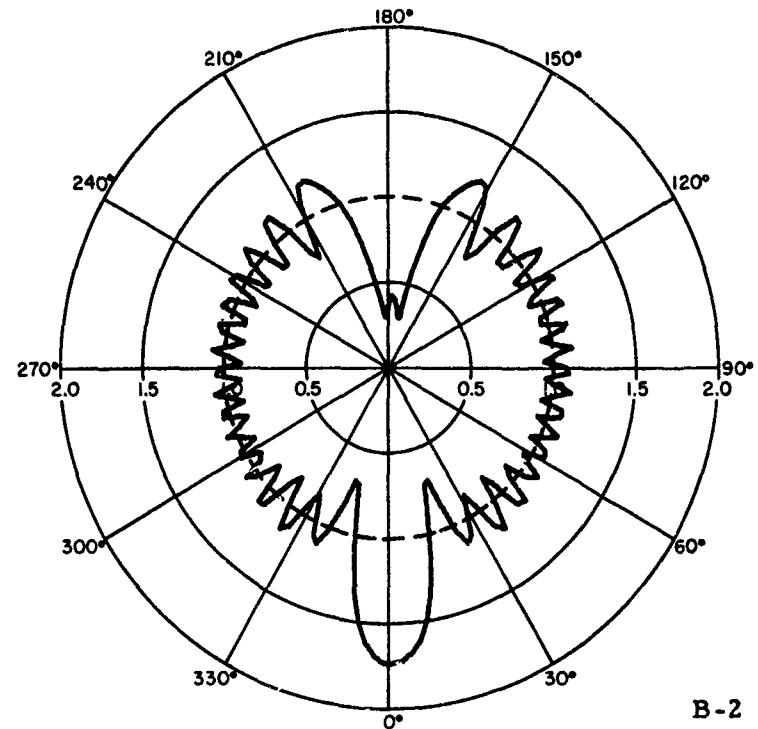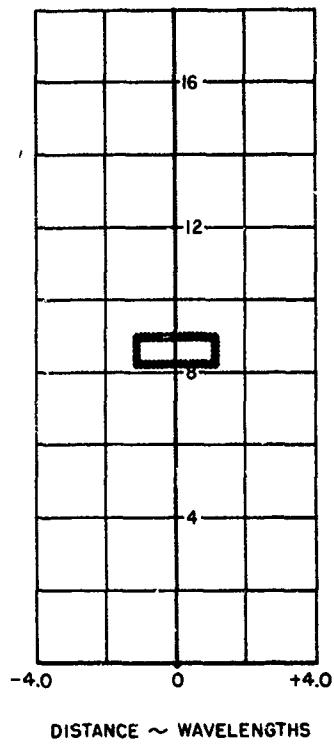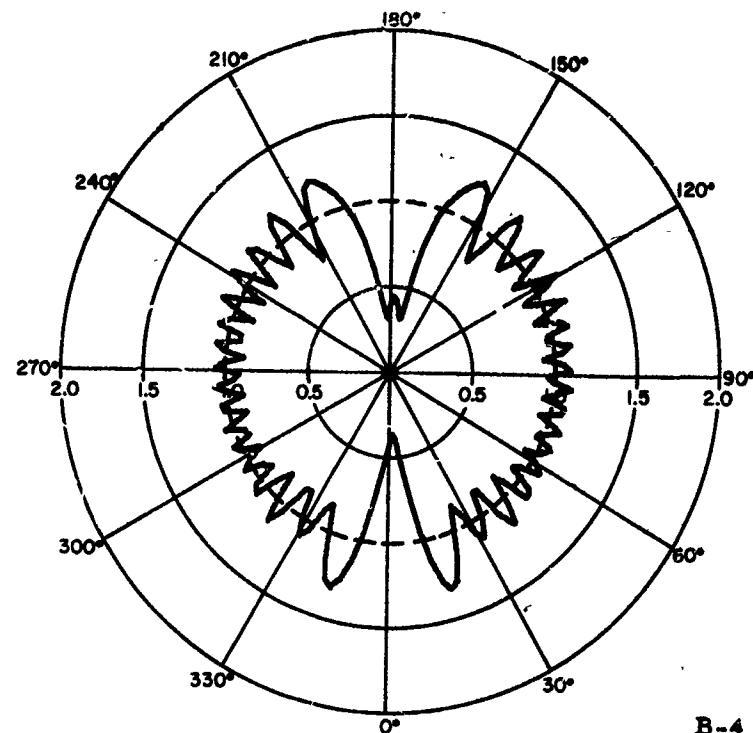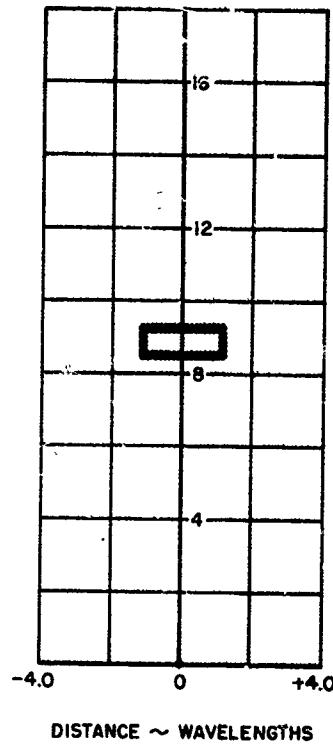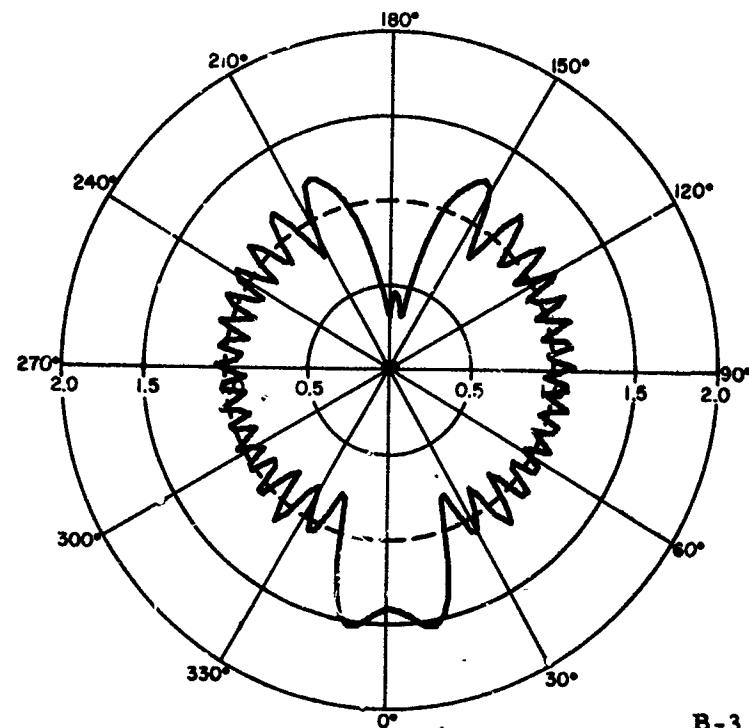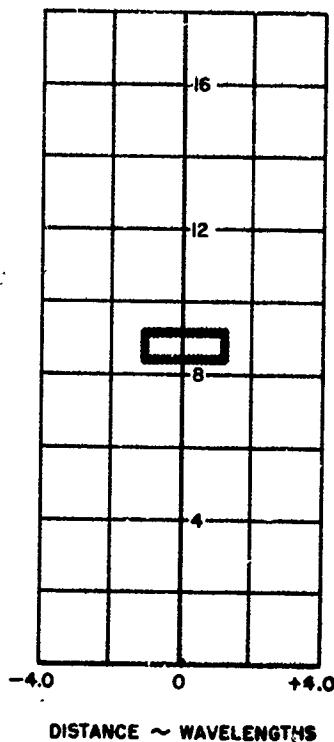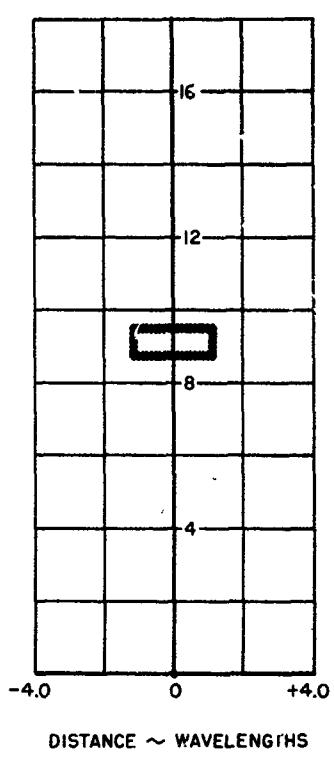
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DISTANCE ~ WAVELENGTHS

B-2

DISTANCE ~ WAVELENGTHS

B-1

191

DISTANCE ~ WAVELENGTHS

B-4

DISTANCE ~ WAVELENGTHS

B-3

192

DISTANCE ~ WAVELENGTHS

B-6

D'STANCE ~ WAVELENGTHS

B-5

193

DISTANCE ~ WAVELENGTHS

B-8

DISTANCE ~ WAVELENGTHS

B-7

194

DISTANCE ~ WAVELENGTHS

B-10

DISTANCE ~ WAVELENGTHS

B-9

195

DISTANCE ~ WAVELENGTHS

B-12

DISTANCE ~ WAVELENGTHS

B-11

196
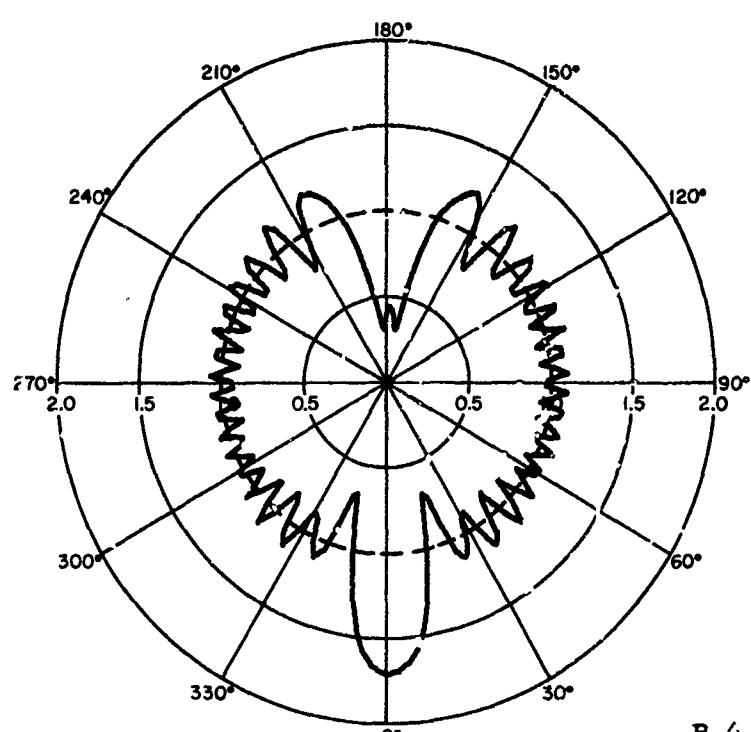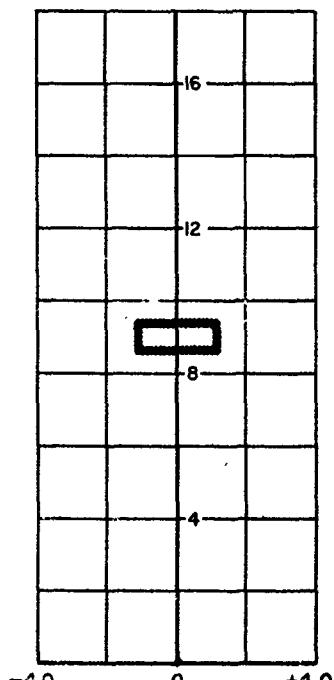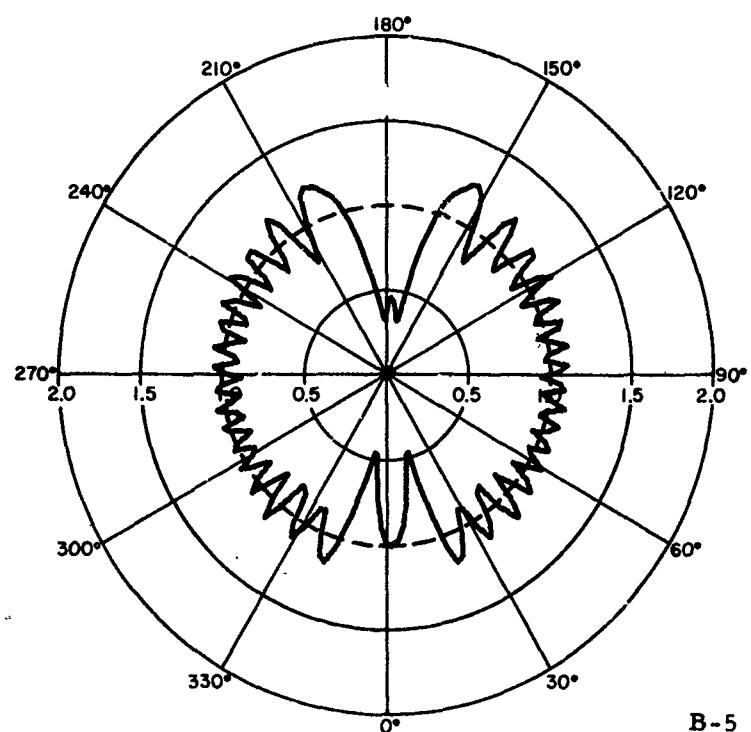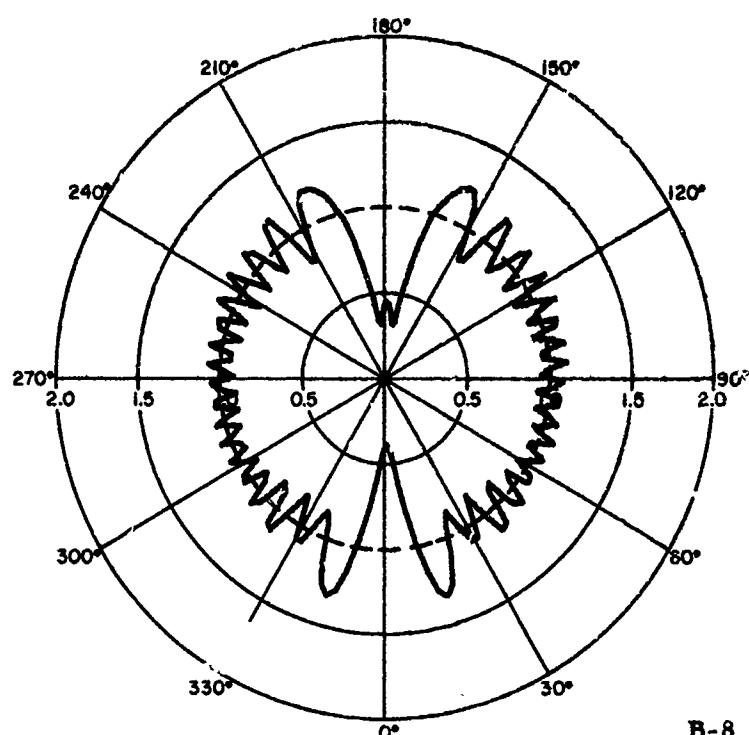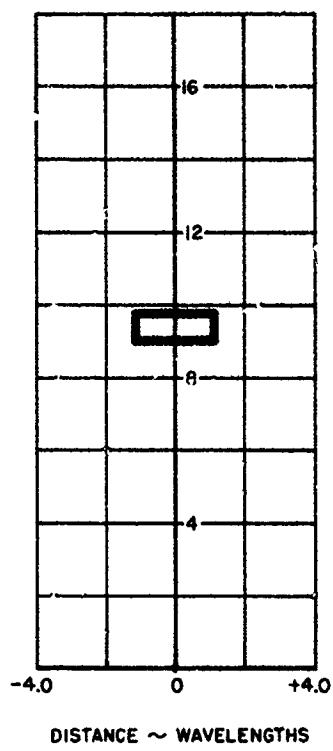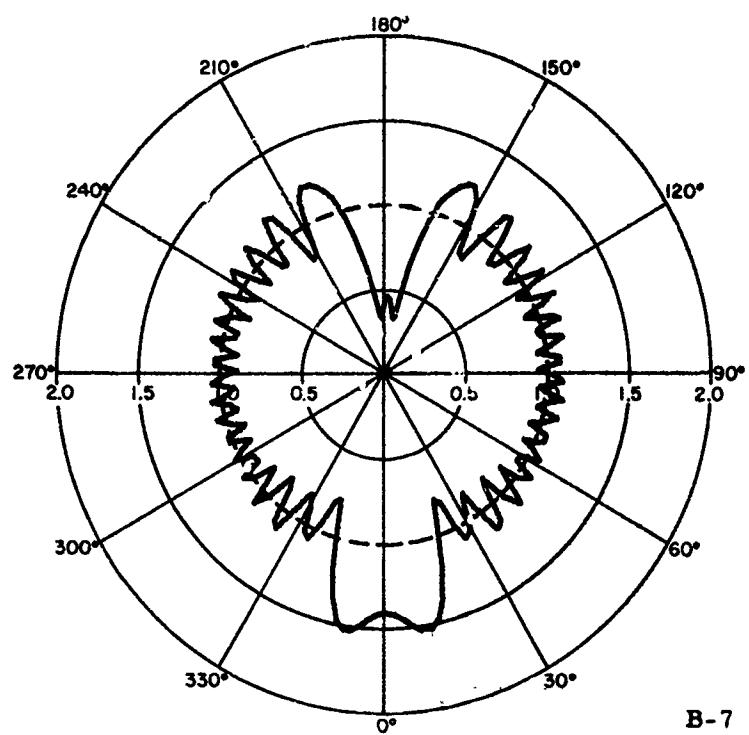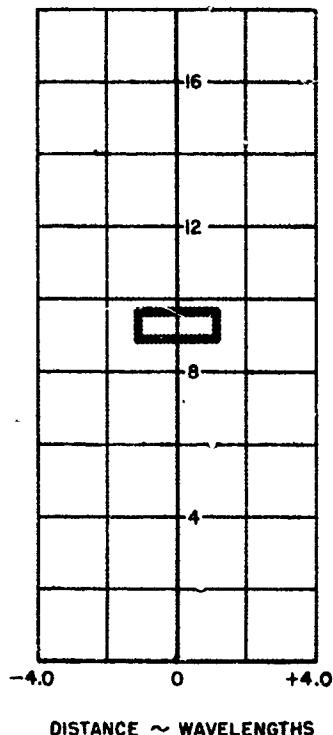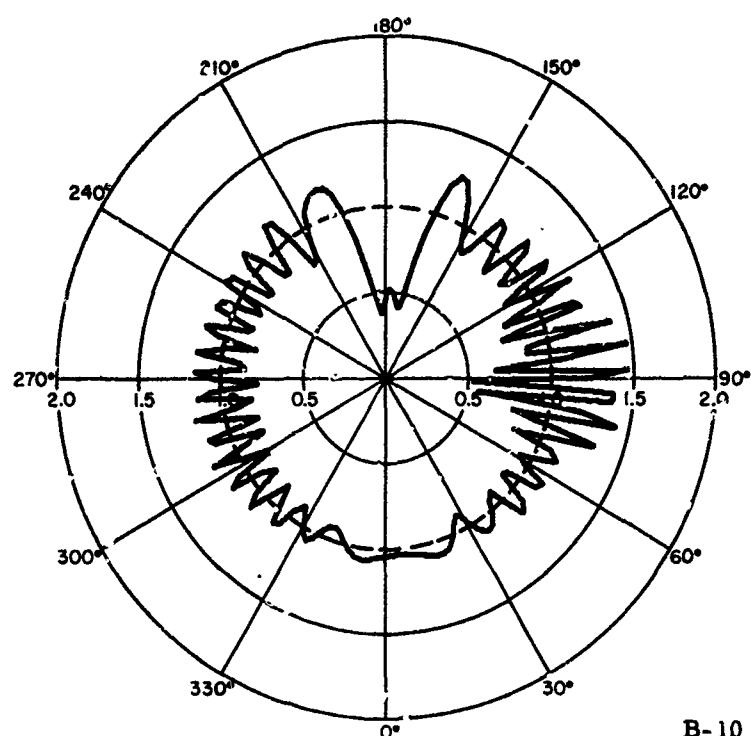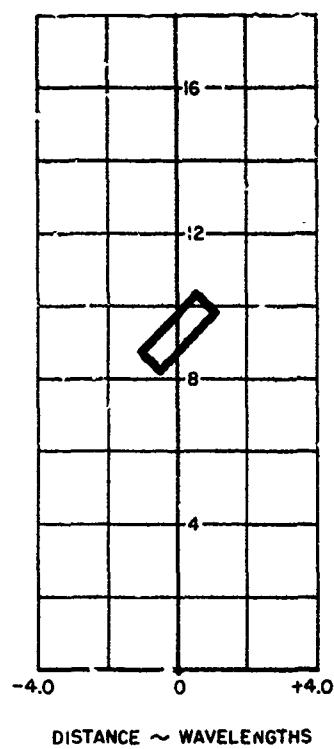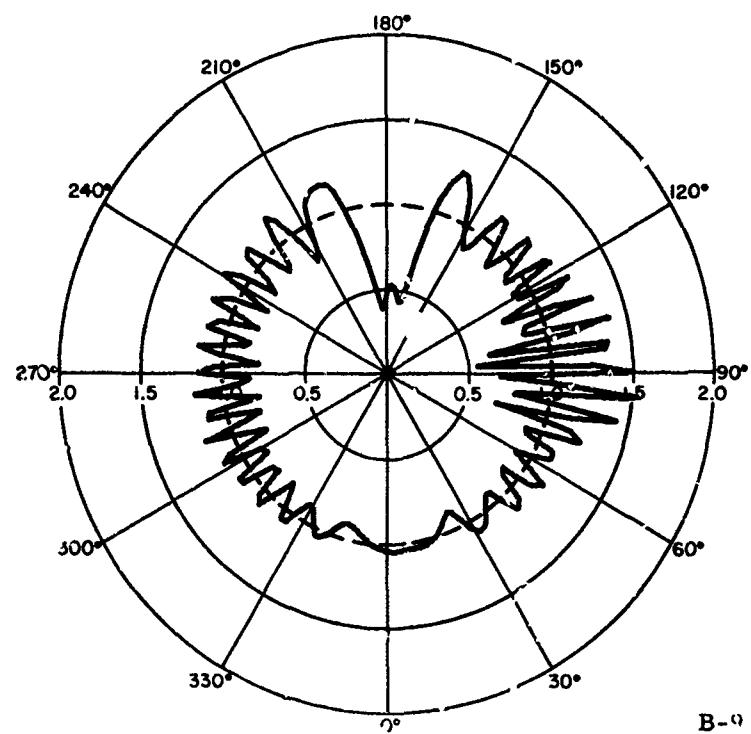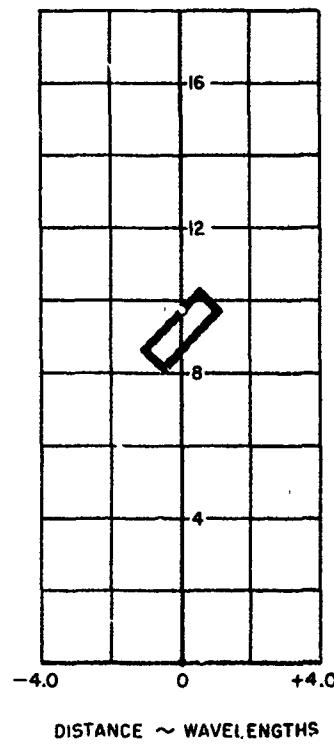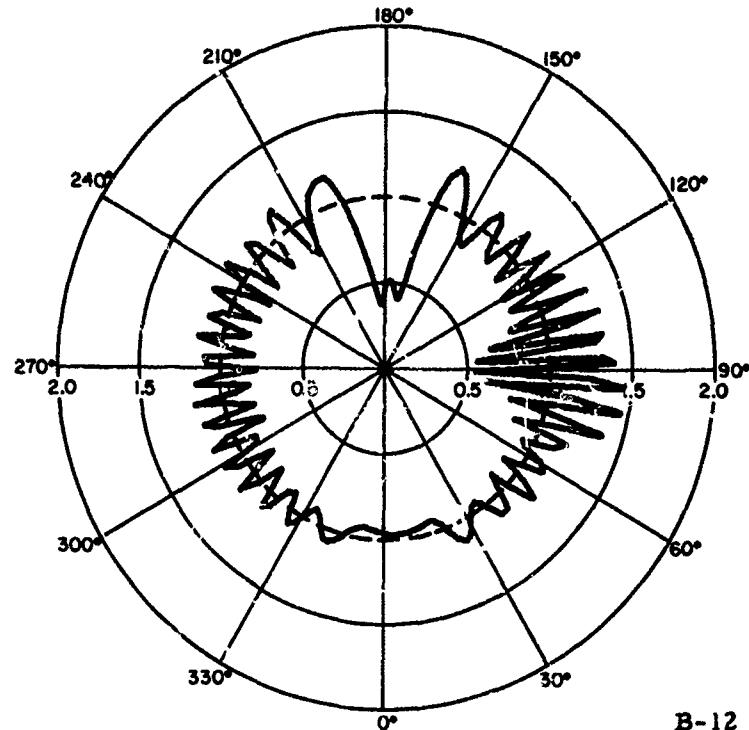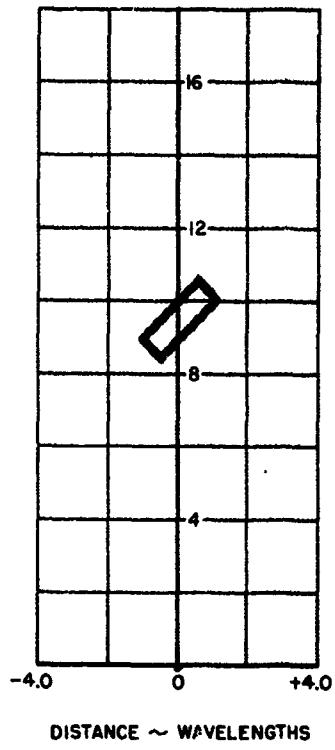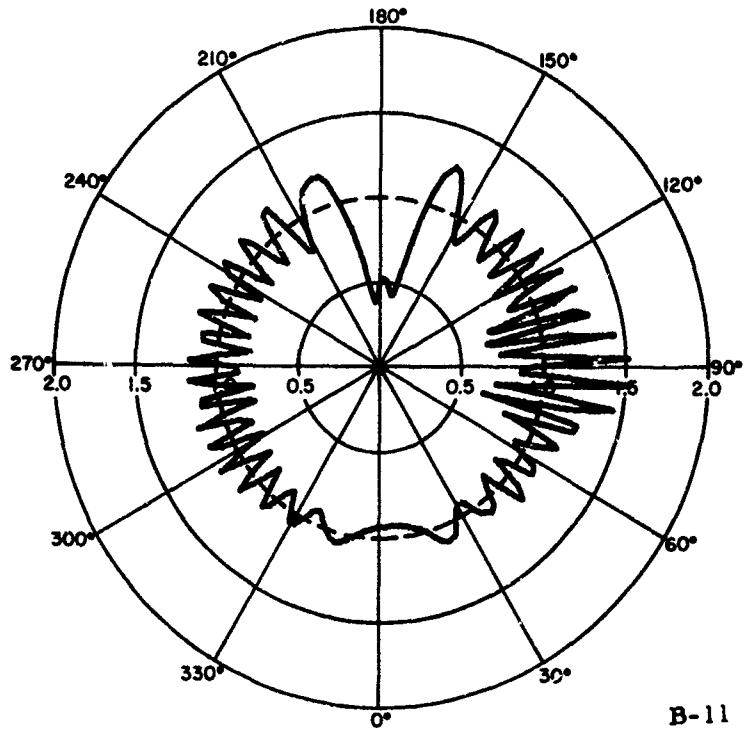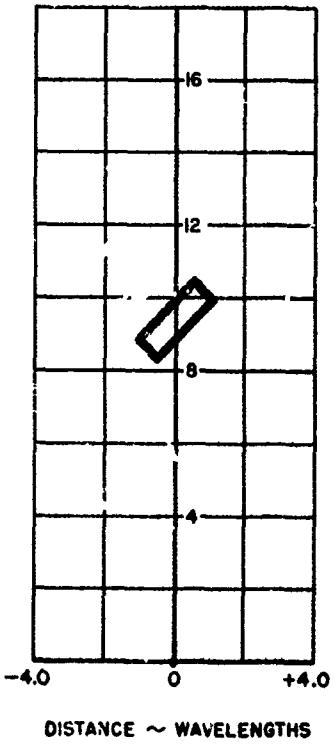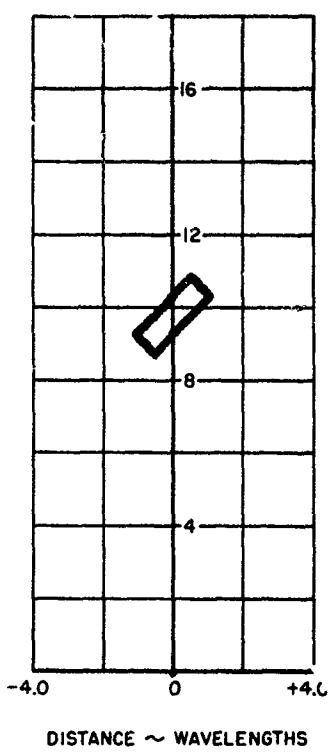
DISTANCE ~ WAVELENGTHS
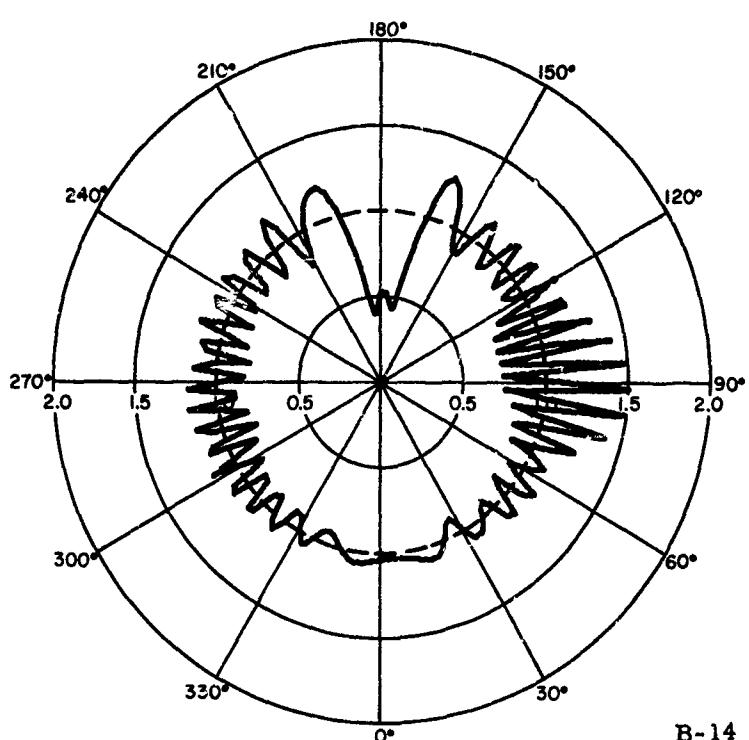
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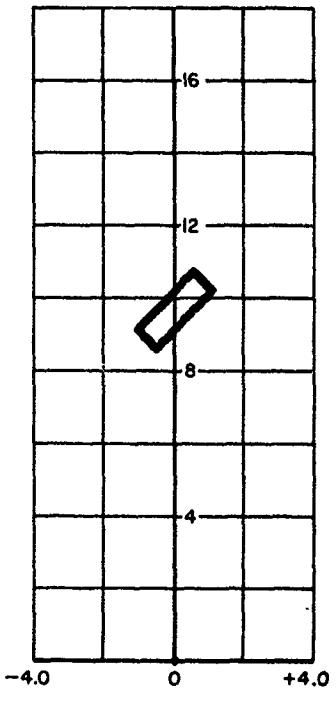
DISTANCE ~ WAVELENGTHS

B-13

197
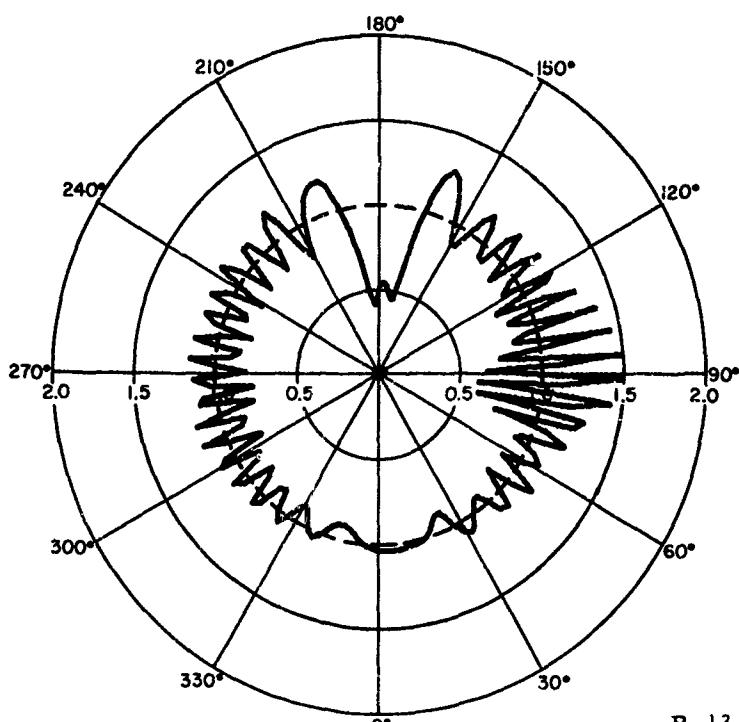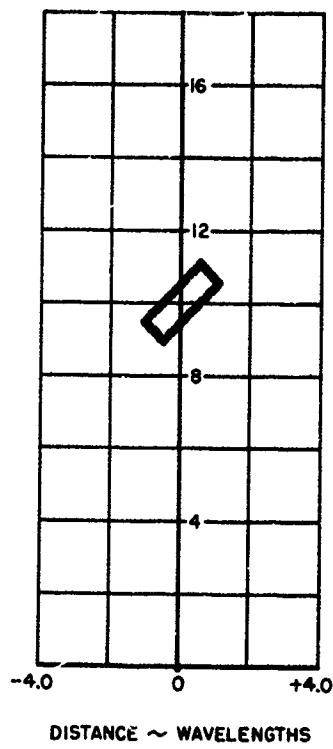
DISTANCE ~ WAVELENGTHS

B-16

DISTANCE ~ WAVELENGTHS

B-15

198

DISTANCE ~ WAVELENGTHS

B-18

DISTANCE ~ WAVELENGTHS

B-17

DISTANCE ~ WAVELENGTHS

B-20

DISTANCE ~ WAVELENGTHS

B-19

200
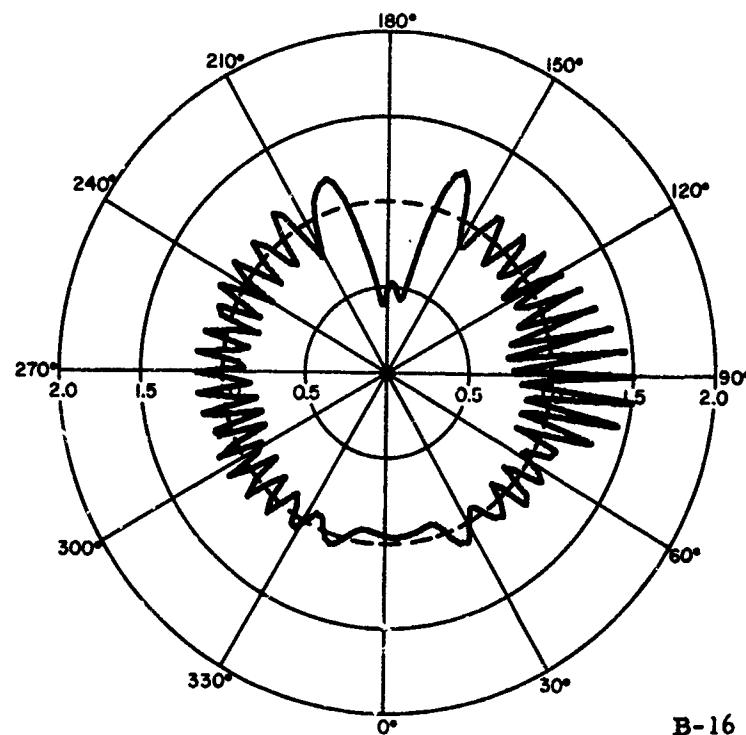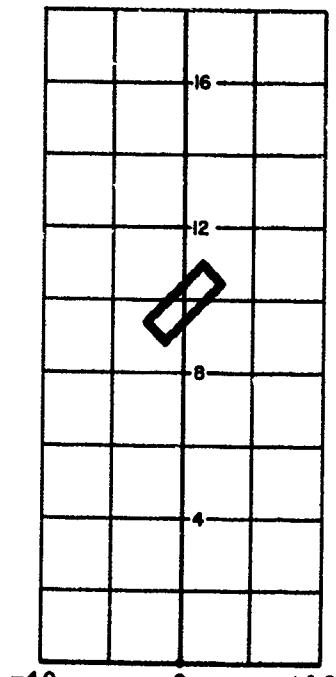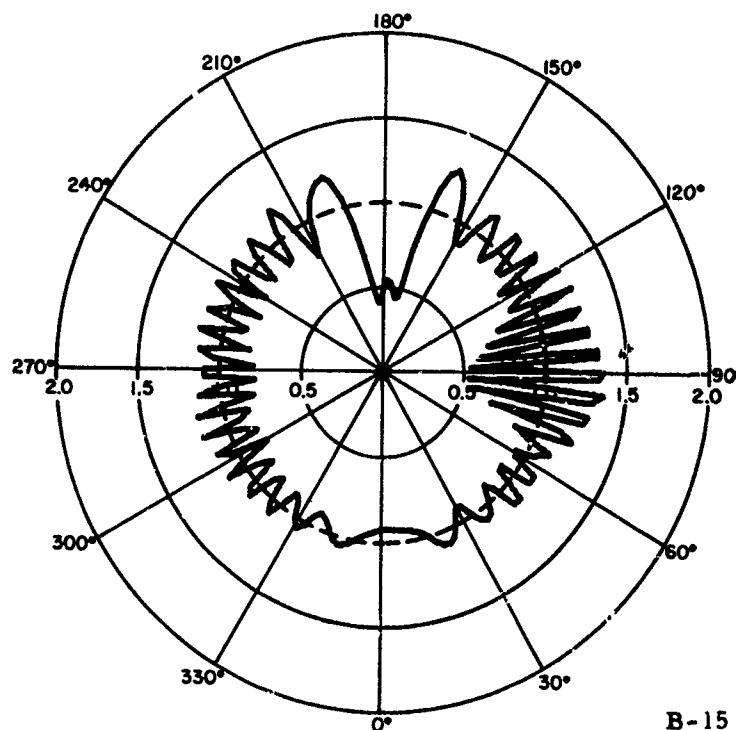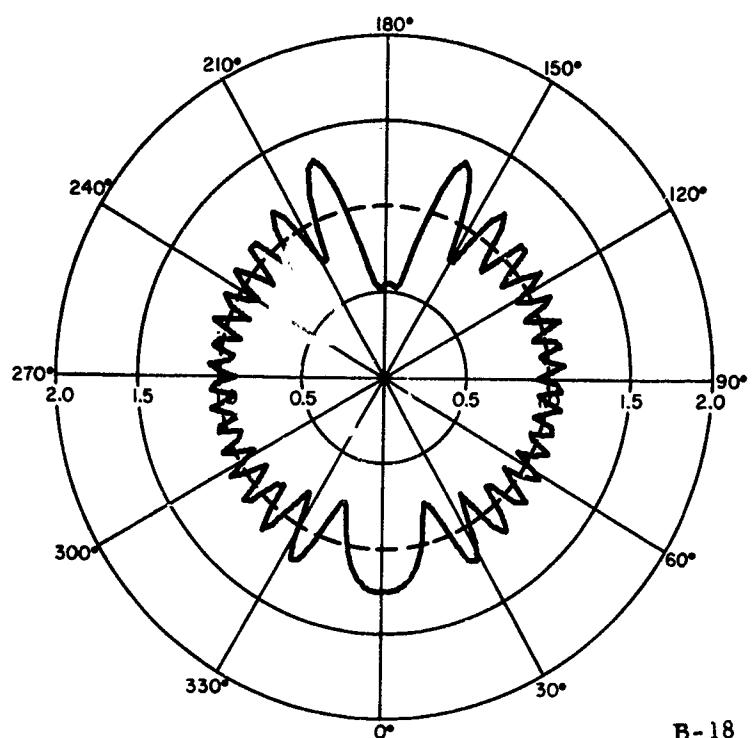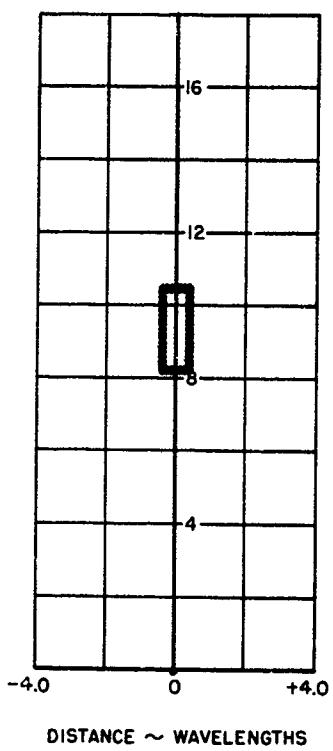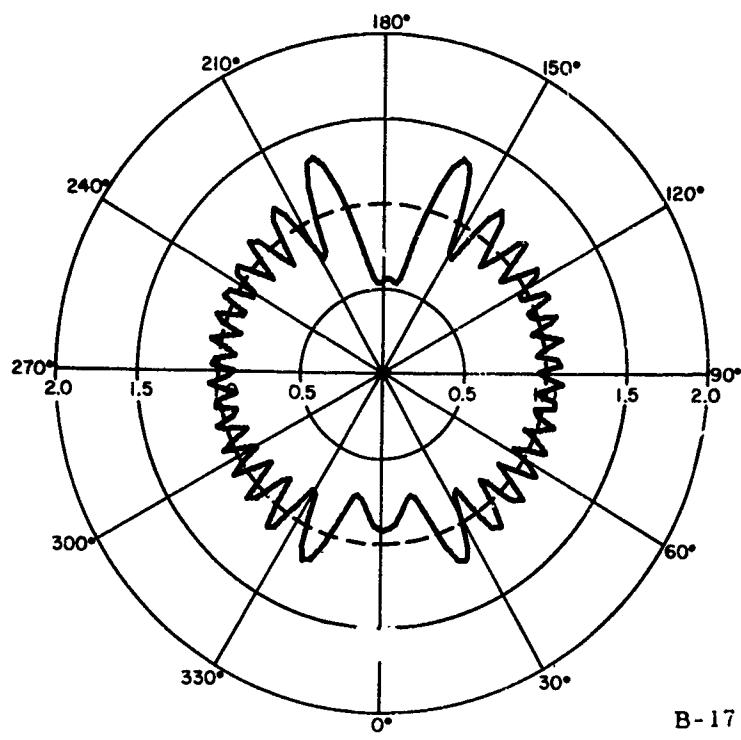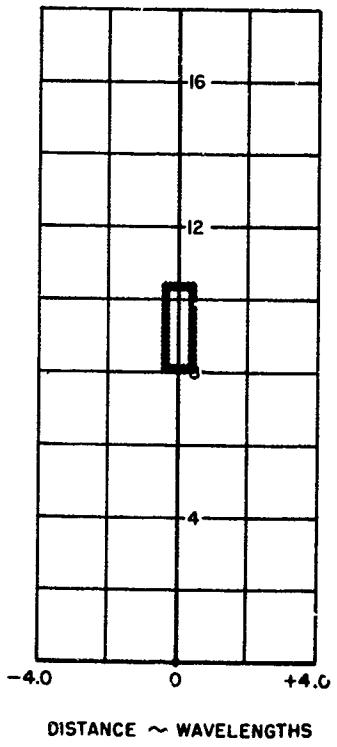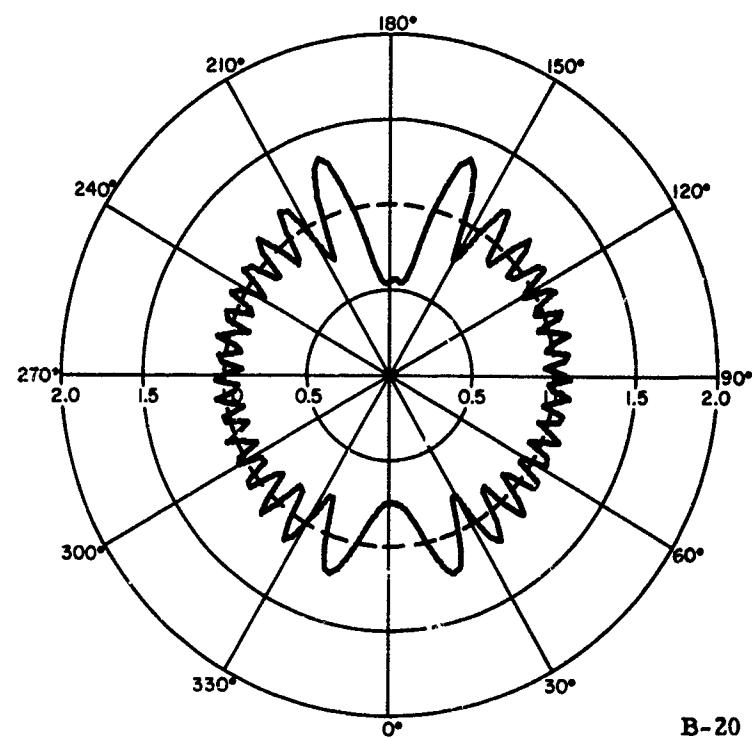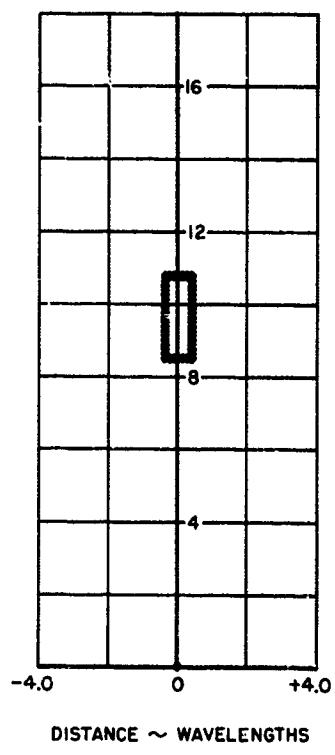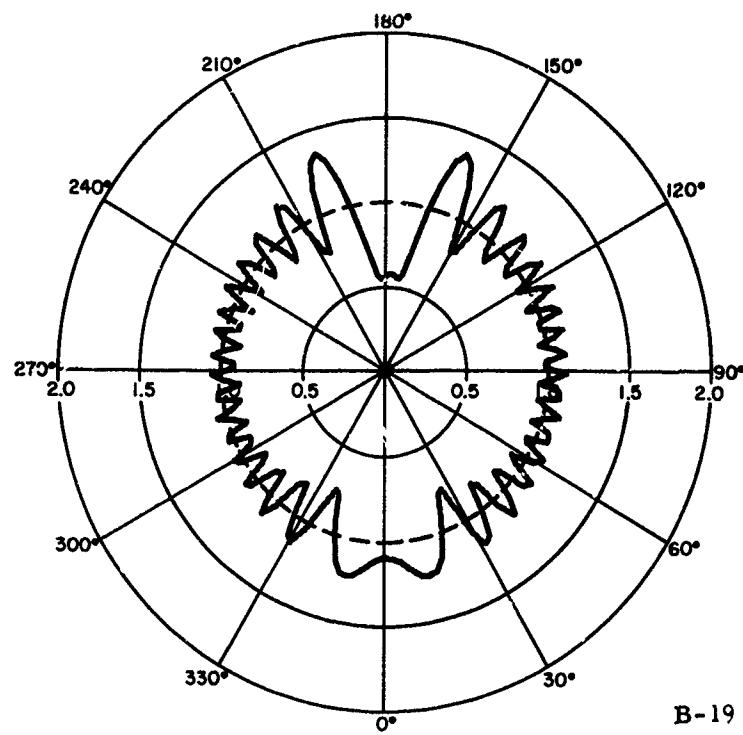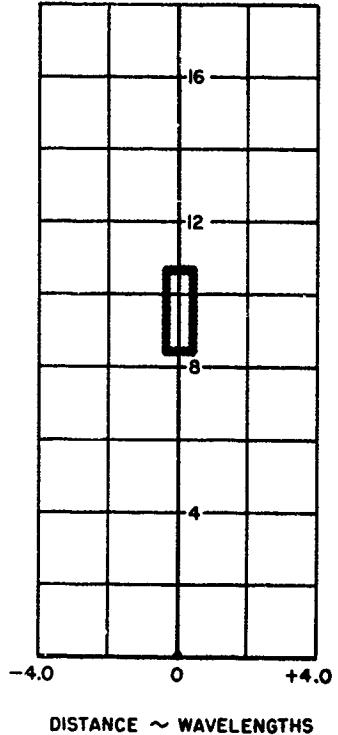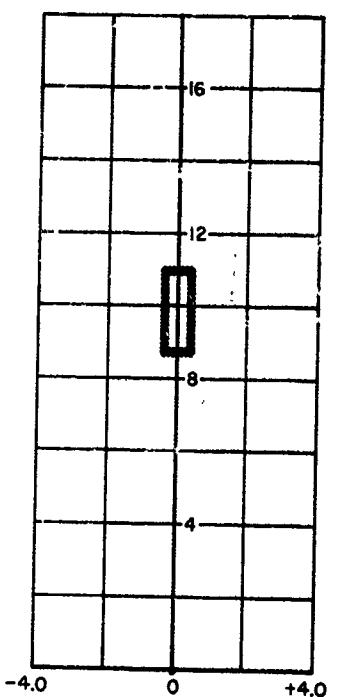
DISTANCE ~ WAVELENGTHS

B-22

DISTANCE ~ WAVELENGTHS

B-21

201

DISTANCE ~ WAVELENGTHS

B-24

DISTANCE ~ WAVELENGTHS

B-23

202
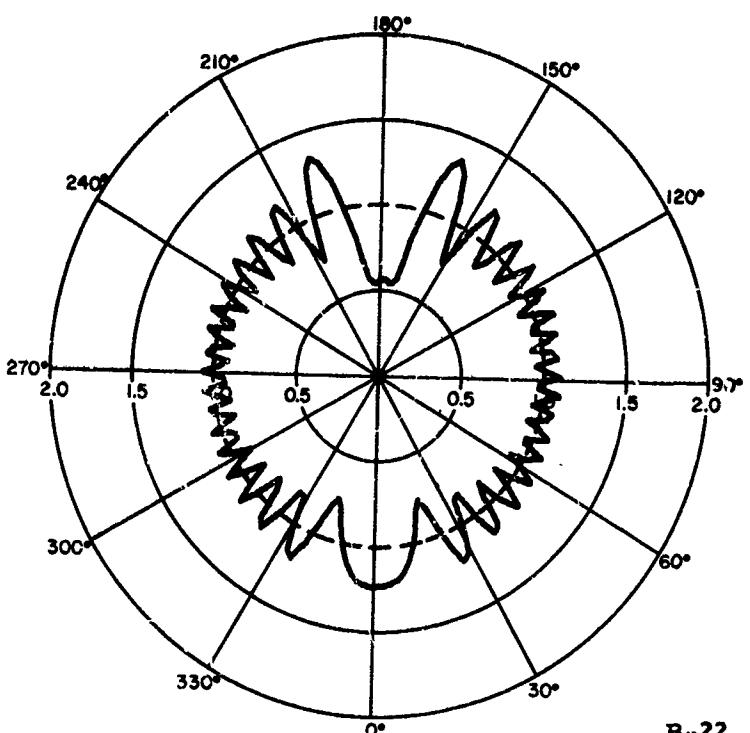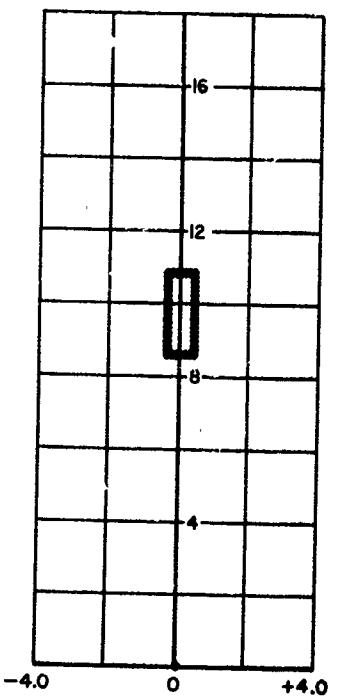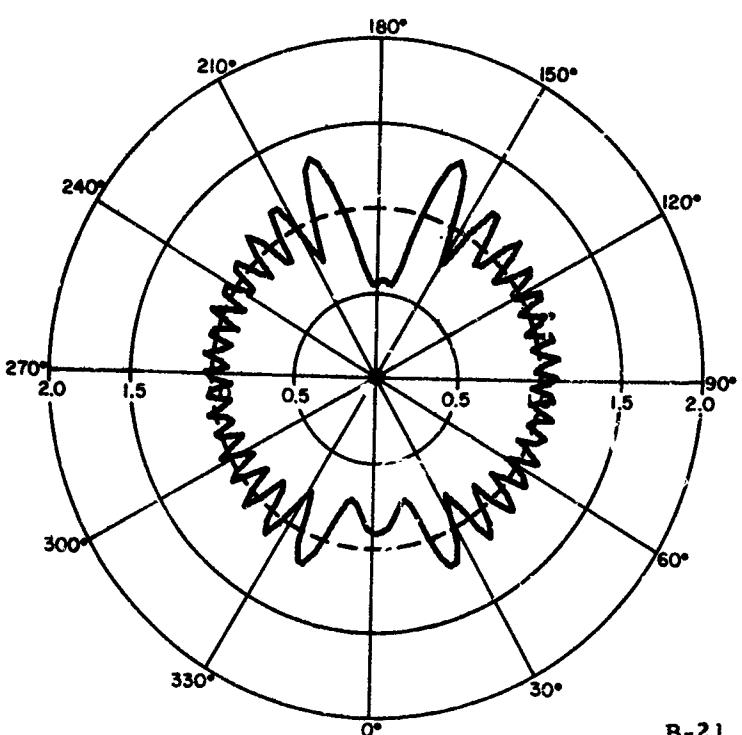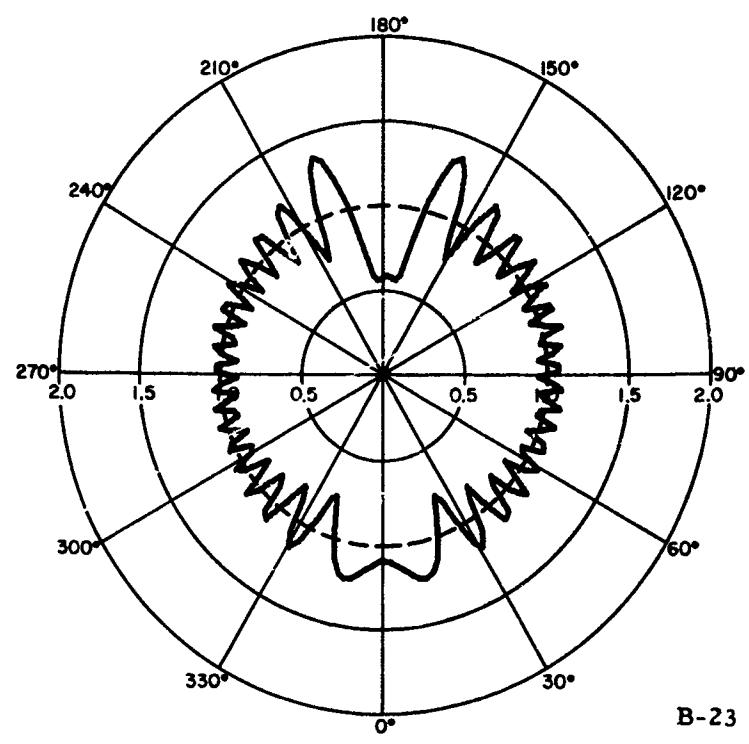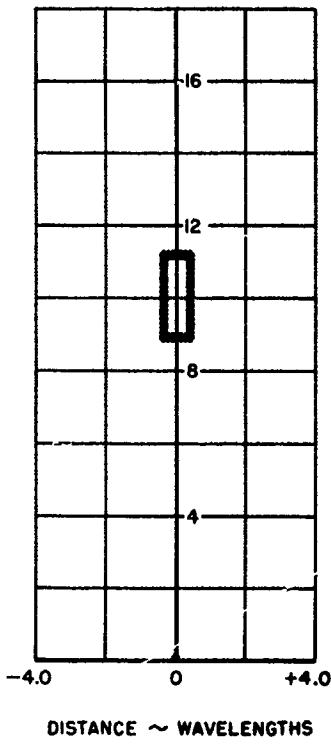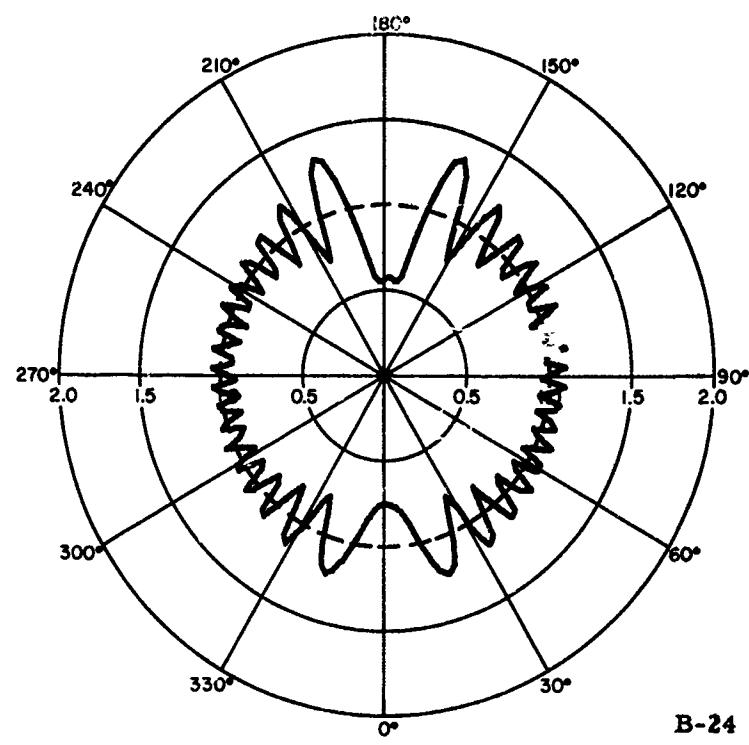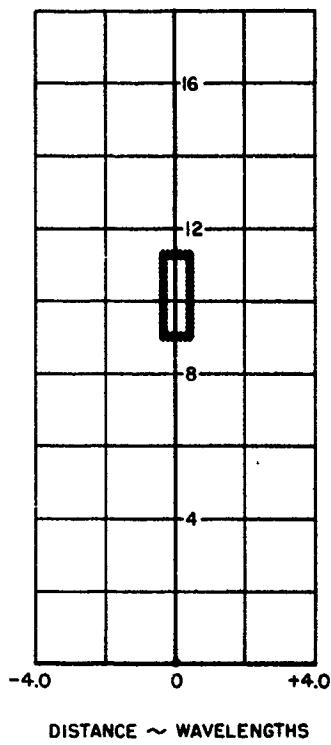
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    prepared under Contract Number N123(953)-31663A, United
    States Navy Electronics Laboratory, San Diego, California.
    (AD 443 833).

2. Thiele, Gary A., "Far-Field Pattern Prediction for Shipboard
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